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# State of the Environment Reporting: Source Book of Methods and Approaches

Paul C. Rump

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# PREFACE

Credible environmental information is an essential ingredient for effective sustainable development policy making and action planning. With sound information, the chances for improved and integrated decisions are increased. Such information does not guarantee a healthier environment, but the lack of appropriate information is a serious impediment to taking sound and rational decisions and to working towards a sustainable future.

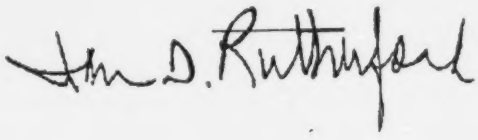
The demand to establish and strengthen environmental reporting programs is high. State of the Environment (SOE) Reporting represents one way of developing and communicating environmental information to decision makers. Many SOE reports have been produced at a variety of levels and formats. Ideally, local, sectoral, corporate, national, regional, and global reports should all complement each other, taking advantage of, for example, common spatial units and databases wherever possible. Reality is not as smooth; due in part to the lack of comprehensive and definitive information on the approaches and methods that are available to deliver quality information that meets the needs of today's decision makers. Therefore, Environment Canada, the Netherlands National Institute of Public Health and Environment (RIVM), and the United Nations Environment Programme (UNEP) joined forces to develop a tool box for environmental reporting. This Source Book is the result.

The Source Book is meant to help move towards greater harmonization of environmental information through development and encouragement of common approaches, practices, and terminology. It is recognized, however, that flexibility of reporting approaches will need to be maintained to meet diverse objectives and user needs. Therefore, the Source Book provides a comparative evaluation of the various alternative approaches that are available for the development, production, and dissemination of environmental information. It brings together the collective experience in the field of environmental reporting. It covers all aspects of reporting from client needs to data supply. Chapters cover the institutional arrangements for reporting, the significance of conceptual frameworks, data requirements, the development of environmental indicators, forecasting future environmental states, and reporting products and their dissemination. Many examples from existing reporting programs illustrate the practical application of concepts, methods, approaches, and techniques.

Harmonizing efforts at the national level will improve the international comparability of environmental and sustainable development information. The result can be used to advance international collaboration and joint action on issues of common concern. It can also simplify, integrate and reduce the workload for national reporting to international forums such as the Commission on Sustainable Development and the Conferences of the Parties to international conventions, while at the same time assisting international appraisal of progress made towards implementation of Agenda 21. We hope that this Source Book will contribute to these needs and efforts.

From initial reactions already received on the Source Book, we believe it will be a very valuable product for those who are in the process of embarking on new reporting initiatives or who are evaluating and further developing existing environmental reporting programs. The report will be an important reference for practitioners in the field of reporting, and for training purposes and capacity building activities. In addition, agencies with reporting

mandates will be able to use this Source Book to develop more detailed, complementary, practical hands-on guidelines on SOE reporting for use in capacity building programs and to encourage harmonization in environmental reporting.



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| | |
|---|---|
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# I INTRODUCTION

## 1 What is State of the Environment Reporting?

The purpose of State of the Environment Reporting (SOER) is to support sustainable development decision making through the provision of credible environmental information. This is accomplished by the development of objective, comprehensive and science-based information on environmental conditions and trends, including their significance. SOER employs an integrated, holistic approach. Three key characteristics are fundamental to SOER: a) the interpretation, assessment and integration of high-quality data to generate meaningful information; b) the development of spatial and temporal trend information; and c) the linkage between environment and socioeconomic considerations within a sustainable development context. Such reporting is essential for providing objective environmental information comparable to that available in the socioeconomic domain. In this way, SOER provides a building block to facilitate improved sustainable development decision making. Access to improved information does not guarantee better decisions. However, it should reduce the risk of unsustainable policies and actions.

SOER includes both the substantive aspects of improving environmental information and the process used to produce such information. The substance is represented by the conceptual frameworks used and the reporting products which are disseminated to increase public awareness and facilitate improved decision making. However, SOER incorporates a dynamic and continuous process to improve the generation and use of environmental information for measuring progress towards sustainability. This process includes the development of integrated databases, consultation and the use of partnerships, and capacity building.

To provide value, SOER should go beyond the discussion of environmental issues, the description of the biophysical environment, and the presentation of environmental data. As a first step, such reporting should be concerned with the analysis of conditions and trends in the environment and their causes. Second, it should assess and interpret the implications and impacts of these trends to human health, the economy, and ecosystems. A third aspect, provides an assessment of actual and potential societal response to environmental problems in the context of the state of the environment. This assessment should be based on quantitative data and integrated analysis to the extent possible. With this focus, balanced environmental reporting aims to answer fundamental questions about the interactions between the environment and socio-economic factors which are significant to policy decision makers and the public. These questions are summarized in Table 1-1.

From this perspective, three objectives can be specified for SOER:

- to increase awareness and understanding of environmental trends and conditions, and their causes and consequences among all stakeholders;
- to provide a foundation for improved decision making at all levels, from the individual to national governments and international organizations;
- to facilitate the measurement of progress towards sustainability.

**TABLE 1-1**

**BASIC QUESTIONS FOR STATE OF THE ENVIRONMENT REPORTING**

| |
|---|
| • What is Happening?<br>**• What are the Environmental Conditions and Trends?** |
| • Why is it Happening?<br>**• What are the Human and Natural Causes of these Changes?** |
| • Are the Changes Significant?<br>**• What are the Health, Economic, Social and Ecological Implications?** |
| • What is and What could be Our Response?<br>**• What are the Environmental Implications of Societal Response?** |

These overall objectives should be common to all SOER programs. Of course, they are linked to each other. One cannot expect environmentally sound decision making or progress towards sustainability without a reasonable level of environmental consciousness. However, it may be appropriate for individual programs to focus on one or two of the objectives depending on national or regional circumstances. If public awareness of the environment and its place in sustainable development is low, reporting to establish a benchmark aimed at increasing public knowledge and understanding represents a logical starting point. Subsequently, the focus can shift to emphasize information to facilitate decision making and progress assessment. At the same time, with a baseline of stakeholder awareness, it may well be appropriate to adjust the reporting to meet more sophisticated and profound awareness needs.

In addition to these primary objectives, there are a number of other results that can be anticipated from an SOER program. SOER can provide an early warning of emerging environmental problems; and identify knowledge and information deficiencies impeding the understanding and interpretation of environmental conditions and trends. Such programs can both contribute to the evaluation of societal response to environmental issues through policy and program performance assessment; and encourage the incorporation of environmental considerations in the development of economic and social policies. Finally, SOER can contribute to capacity building and reporting at other spatial levels. National reporting programs should assist governments in meeting international reporting requirements. In addition, a national program can include in its objectives the advancement of sub-national reporting. Again, the inclusion or degree of emphasis on these aspects should be considered in the design of individual reporting programs.

## 2 Purpose of this Source Book

Under its Environmental Assessment and Reporting initiative, the United Nations Environment Programme (UNEP) provides environmental information to support international sustainable development policy development. The three key strategies used to achieve this mandate are:

- the continuous review of the state of the global environment;

- the development, dissemination and use of integrated information at regional and global scales; and

- the promotion of state of the environment reporting at regional and national scales.

This Source Book is primarily directed at supporting the third strategy, but there is an obvious symbiotic relationship among all three strategies. An advance in national state of the environment reporting will strengthen global reporting and access to integrated environmental information.

Many countries and organizations have completed state of the environment reports as specific projects or as part of a larger environmental information program. The aim of this Source Book, therefore, is not to describe and promote a new activity, but to build on what has already been achieved in the reporting field. Some experience with SOER programs has been documented (for example, see Comolet, 1993; and Parker and Hope, 1992), but there is little systematic and comprehensive information on the methods and approaches to deliver quality state of the environment information to support sustainable development decision making.

At the same time, there is an expanded emphasis on environmental reporting to meet the needs of sustainable development policy making particularly at the national level. The United Nations Conference on Environment and Development (UNCED) approved Agenda 21 as an international action plan for sustainable development. Chapter 40 of Agenda 21 calls for improved environmental information as a prerequisite for reporting on our progress towards sustainability (United Nations Conference on Environment and Development, 1992). The United Nations Department for Policy Coordination and Sustainable Development (UNDPCSD) is now working with national governments and others to implement these reporting requirements. National governments when they ratify various international conventions or are members of regional organizations face considerable reporting requirements. In addition, governments may well have national environmental reporting demands that must be met to satisfy legislative and policy directives.

SOER represents an approach to provide the integrated, comprehensive, and timely information required to support improved decision making. However, it is important that reporting programs are optimally designed and implemented to meet multi-dimensional demands. The objective of this Source Book is to support the development of the most efficient and effective SOER programs at national and regional levels by providing information on strategies, methods, approaches, tools, and best practices in the field. The Source Book represents an effort to share the reporting experiences of institutions which have already established reporting programs. It will not provide a single definitive pathway or rigid guidelines for a SOER organization, but will provide food for thought, guidance, and options for countries and institutions which are either establishing reporting programs or are in the process of evaluating existing reporting initiatives. The Source Book should also provide a valuable reference for training and capacity building in the area of environmental information.

The responsibility for reporting programs rests with national governments or the regional and global institutions they have cooperatively established. Their representatives will have to decide on the scope and shape of the most desirable and feasible reporting program to meet national and regional needs. This Source Book should help those making such decisions.

Flexibility must be inherent in reporting programs if they are to meet regional, national and global needs. However, it is hoped that the guidance and direction derived from the Source Book will encourage the generation of improved information for awareness raising and decision making, and contribute to the greater harmonization and comparability of information between reporting initiatives.

## 3 The Evolution of SOER

State of the Environment Reporting first developed in the late 1970s in response to society's concern over the quality of the environment and the use of natural resources (Avérous, 1989). Since the early prototype reports from such countries as Japan and the United States, the context for SOER has shifted to be within a broader thrust of formulating sustainable development and conservation strategies, demonstrating environment-socioeconomic linkages, and measuring environmental performance. The fulfillment of the public's "right to know" underlies this rationale for providing environmental information. Over the last fifteen years, national governments, international organizations, non-government organizations, and the private sector have produced a plethora of state of the environment (SOE) reports with a scope ranging from global to local.

No definitive inventory of SOER programs or the resulting SOE reports exists. However, from various available inventories, it is apparent that several hundred such reports have been produced by all regions of the world if regional, national, municipal, and corporate reports are included (see for example: World Resources Institute, International Institute for Environment and Development, and The World Conservation Union, 1992; Hodge, 1994; and Pierce, 1994).

The impetus for SOER originated as part of a broader environmental movement stemming from public and community pressure for more pluralistic and democratic societies. Several international organizations, including UNEP, The World Conservation Union (IUCN), the Organisation for Economic Co-operation and Development (OECD), and the Economic and Social Commission for Asia and the Pacific (ESCAP), soon incorporated reporting as part of their mandates. Reporting initiatives have frequently been legislated by national governments, while notable early innovative examples were completed by private sector organizations or citizen groups such as the Indian Centre for Science and the Environment and the U.S. Conservation Foundation. In the late 1980s SOE reports for local government and major corporations began to be produced. Often the organization of early reports tended to be based on an environmental media or human activity structure. In many examples, selected environmental issues were also analyzed. The typical spatial framework employed reflected administrative or jurisdictional boundaries.

The products--the vehicles for reaching clients--represent an significant dimension of SOER. In the past, the typical SOE product consisted of a periodic, printed report at the appropriate spatial scale. The reports were largely descriptive and concentrated on past trends and current conditions. The emphasis of early reports tended to focus on awareness raising rather than making a direct contribution to decision making.

Such a typical reporting program is now recognised as being of limited value for decision maker needs. This does not mean, however, that we discard the periodic, retrospective assessment. Such a product can serve as a valuable and comprehensive reference tool from which information for policy and investment decision making can be easily derived. Nevertheless, we need to build on this base to develop more flexible, consultative, and

accessible reporting programs which provide continuous, more timely and integrated information using multiple formats to meet a variety of user needs. Only in this way will we be able to grapple with current and future development processes.

## 4 Characteristics of State of the Environment Reporting

For future success, the collective SOE process must be more effective at meeting decision making needs. In future products, information on the environment must be clearly positioned within a sustainable development context. In other words, the starting focus for SOER is the environment, but the linkages to socioeconomic factors should be made explicitly. Reporting should address the underlying forces of environmental change, and cover both environmental quality and natural resources. Providing information in an issue context with emphasis on causal links and significance will enhance the usefulness of the information. This positioning will meet the dual requirements of strengthening the development of environmental information and coupling it to the social and economic domains.

In a broader context, SOER must respect and acknowledge the cultural setting and its influence on the meaning of sustainable development. The traditions, values, heritage, and political system of a country or region will influence the reporting perspective. Whether the region in question is highly industrialized, dependent on natural resources, located in the "north" or the "south", has a multi-cultural population will all influence the design, scope, and products of a reporting program. In addition, the issue selection and the emphasis of the interpretation and assessment for reporting will reflect such regional differences. This accommodation of differing perspectives is appropriate. However, increased comparability would be achieved if we all talked a common language, adopted compatible conceptual frameworks, and used harmonized data and comparable indicators. Such harmonization will not be easy to achieve, but various initiatives are making important progress in these areas at national, regional and global scales.

It is important that the SOER process be open, consultative and inclusive. Sustainable development decision making requires the perspectives of all segments of society including the private sector, government institutions, non-government organizations, academia, indigenous people, and the interested lay public. This can be achieved in a number of ways ranging from strategic advisory committees, to project design consultations, to peer reviews, and to feedback on products. Special emphasis on education and capacity building may be necessary to assure that all voices are heard.

Inherent in SOER, especially from a sustainable development context, is the application of an ecosystem approach which recognises the complexity of ecosystems, our limited ecosystems knowledge, and the importance of ecosystem functions and relationships (see Chapter III). With this in mind, the application of an hierarchical or nested ecosystem spatial framework developed from consideration of all ecosystem elements is an indispensable tool of SOER. Such an integrated framework is compatible with sustainable development thinking and should be adopted for reporting at national, regional and global levels. Nevertheless, reference to administrative boundaries will continue to be necessary to maintain policy and decision maker relevance.

With ecosystems constantly evolving, it is important to provide a temporal context for decision makers by reporting on past, current and future trends. A common historical trend period, for example 20 years, can be used as a guide, but considerable flexibility is required to reflect ecosystem and decision making circumstances. It is important to anticipate and

forecast future consequences of pressures on the environment (see Chapter VI). If current global trends in consumption, population and economic growth continue, the pressure on the environment will increase causing further change. There may be some considerable time delay before the ecosystem responds to new or additional pressure. For example, groundwater impairment from fertilizer application may not be evident for several years. At this juncture, preventative action is too late. Furthermore, the implications of new policy and development options on environmental conditions need to be examined in advance of implementation. In terms of such scenario construction to predict future states of the environment, various time scales may be appropriate, but usually range from a five year to a 50 year horizon.

The value of SOER lies in the transformation of disparate data and information into meaningful and relevant material for awareness raising and decision making. In general, we have an abundance of existing data and information from monitoring systems, surveys and remotely sensed sources. However, the bulk of these data tend to be project, research and sectoral based. They are not succinct, comprehensive, nor integrated from discipline, spatial or temporal perspectives. The quality, comparability and compatibility of data are frequently lacking to facilitate our full understanding of ecosystems. We are changing our management approach from a sectoral to a sustainable development paradigm, and our data management systems need to be developed and harmonized from the local to the global level to meet this challenge.

The essence of this information dilemma is having access to appropriate and meaningful information for policy decision making. Availability, quality, and accessibility are key characteristics of sound information. With its emphasis on interpretation, assessment and integration of information, SOER represents an important tool in meeting these needs whether in developing or developed countries. The SOER process provides the link between: a) the scientist and the data or knowledge generator; and b) the information user and decision maker. The role of SOER is to bring credible, understandable and timely information to the people who need it using appropriate format vehicles.

The range of SOER products has to be broadened to meet more fully decision maker needs. In addition to various types of reports, maps, audio visual and electronic products can be very powerful in reaching various audiences. Such a multi-media family of vehicles should complement one another to provide a continuous flow of information to facilitate a much more interactive method of analysis and reporting.

SOER reporting represents only one information tool relevant to decision makers (World Resources Institute, International Institute for Environment and Development, and The World Conservation Union, 1992). Descriptive reports or environmental profiles are useful to provide baseline information on the current status of social, economic and environmental conditions in a region. Statistical compendia are commonly used to provide a comprehensive data source for further analysis. SOER products use these sources to provide an integrated assessment and interpretation of the state of the environment. This factual, integrated and balanced analysis provides a solid, credible foundation for the development of sustainable development strategies.

## 5 Principles of SOE Reporting

When establishing, or thinking strategically about an existing SOER program, a set of principles can help guide its development.[1] Such a set cannot be equally and rigidly applied to all programs because of the diversity of circumstances which are present in all countries and regions. Nevertheless, the set offered below can be considered as a first approximation which can be amended or supplemented to suit specific local conditions. The principles are further elaborated and developed in the subsequent chapters of the Source Book.

- The most important direction that an SOER program can take is that it be **demand driven** to meet the decision making needs of users whether they be government policy makers, corporate executives, educators, or the interested public. This means close contact with clients. It also implies that an SOER program should not be totally constrained by data limitations over the longer term. It may well not be the prerogative of the reporting program itself to directly fill data gaps and improve data quality. This responsibility will usually rest with other statistical or natural resource management agencies. However, it is in the best interests of SOER programs to encourage monitoring and survey agencies to move towards data generation which meets the integrated, ecosystem needs related to environmental reporting for sustainable development.

- SOER must respect the **cultural and development diversity** that exists across the ecosphere. The earth is almost a finite system[2] with a limited sustainable carrying capacity. However, we see this world in very different ways. In developing countries, the driving forces for change are related to basic life support needs. In the industrialized world, technology and lifestyles are more important as fundamental pressures on the environment and natural resources. Our perceptions or mental models of how the world works are rooted in our culture, religion, traditions and values, and help explain, and even govern, the way we use information in our decision making. Therefore, we must recognize that there is more than one version of a sustainable future.

- The **added value** of SOER is the integration and interpretation of science-based data and information on a timely basis to give a comprehensive assessment of the state of the environment. Such assessments can be completed through the horizontal integration of environmental, natural resource and related information available at one level, for example, the nation; or through vertical integration of information from various spatial levels. To accomplish this, it is usually not necessary to radically change the existing organizational structure of government. Rather, an SOER unit represents a coordinating mechanism to draw on information from existing organizations, and provide a consistent structure for comprehensive, credible and continuous reporting.

- To achieve its mission, **partnerships** are essential for SOER success (see Chapter II). We do not have all the expertise in one place. Partnerships can share the workload; bring additional perspectives; and lead to increased participation, and greater use and acceptance of analysis and assessments. Responsibilities for the environment and sustainable development are shared among a multitude of agencies, functioning

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1 A set of principles for SOER was initially presented in: Australia Commonwealth Environmental Protection Agency, 1993.

2 External influences include the sun's energy and the moon's gravity effect.

at various levels in government and the private sector. Responsibility for environmental quality, natural resources, and development are frequently found in different agencies. Environmental statistics, environmental reporting, and sustainable development decision making are not usually centralized, but these functions are hopefully linked through various coordination mechanisms. In particular, SOER programs should have good working relationships with data generators, earth scientists, and policy decision makers. In addition, non-governmental organizations and industry can provide valuable advice to achieve a more balanced and credible perspective.

- It is important that SOER be guided by a **conceptual framework** that facilitates the development of information to answer the basic questions posed in Table 1; and makes the linkages between the environment and socioeconomic factors. This does not mean that an SOER program should devote considerable resources to conceptual development. Various existing conceptual frameworks are discussed in Chapter III. While not perfect, they provide reference and guidance for SOER. Such frameworks include the pressure-state-response model, the ecosystem approach, the information hierarchy, and the policy cycle. The pressure-state-response model is the most commonly applied framework in reporting programs today. It provides a systematic categorization of socioeconomic, environmental and natural resource information under four headings: stresses or agents of environmental change, resource assets, environmental quality, and societal response.

  Thinking of ecosystems as an integrating framework which incorporates environmental, economic, and social perspectives is crucial to the achievement of sustainability. Such a dynamic approach emphasizes a holistic rather than a sectoral perspective; stresses the complexity and limited carrying capacity of ecosystems; and focuses attention on the significance of function and relationships of ecosystem attributes. The information hierarchy recognizes the spectrum and linkage between data, statistics, indicators, indices and interpreted information. Under such a hierarchy, the objective is not to include every fact or detail in an SOE product, but to provide synoptic, integrated information from a holistic perspective. In the policy cycle, reporting can emphasize issue definition and analysis, provide information for policy option development, be applied to forecasting, or provide information for policy performance assessment. These frameworks are not mutually exclusive and can be applied to individual reporting programs as circumstances warrant.

- The **spatial and temporal aspects** of SOER represent significant considerations. From an overall perspective, reporting can be completed at the ecosphere, regional[1], national and sub-national or local scales (see Chapter III). Priority environmental issues tend to be different at these various scales. Climate change and ozone depletion are obviously global issues which require action by the global community. Trade-environment and acid rain have global significance, but can also be regarded as important regional issues. National level reporting is particularly relevant because of the policy and response responsibilities at this level. Issues related to land use can often be regarded as sub-national or local in nature. There are many exceptions and overlaps to this broad generalization which is only used for illustrative purposes. In addition, it must be remembered that national governments are ultimately responsible for regional and global initiatives to improve

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[1] In this report, "regional" is used to denote a sub-continental area, for example south-east Asia, rather than a sub-national area.

the state of the environment. Thus, within a national reporting product it is useful to include information addressing other spatial levels--global, regional, and local.

From a spatial context, it is desirable to reference data and information to both administrative and ecological frameworks. This can be accomplished, for example, through the use of geographic information systems (GIS). The ecological regions appropriate at various reporting scales should be nested in a hierarchical system to permit aggregation of data. In addition, ecological regions should be formulated from a total ecosystem perspective which recognizes all factors such as climate, land forms, geology, soils, vegetation, wildlife, water and human attributes.

From a temporal perspective, SOER should encompass the analysis and interpretation of past, current, and future trends to give both a diagnosis and prognosis of environmental conditions. Experience to date has emphasized retrospective analysis. However, forecasts of future states of the environment are important for sustainable development decision making (see Chapter VI).

- SOER should strive for **balance and completeness** with data and indicators which adequately reflect conditions and trends within the environment and the socioeconomic domains. Unfortunately, this is not always possible and we must frequently be satisfied with surrogate data. For example, we have no way of measuring fish stocks directly. Consequently, we must rely on catch data as a crude indicator of the population of various fish species. The same situation applies to many other areas where we may have relatively good records for socioeconomic and emission stressors, but are relatively weak on data reflecting ambient conditions and societal response. For such cases, the use of statistical relationships or cause-effect models can provide useful results, although with a higher degree of uncertainty. Reducing data inadequacies, wherever possible, represents an important long term goal for SOER organizations to foster. Data and indicators for SOER are discussed in Chapters IV and V respectively.

- The **niche for SOER** essentially lies between the scientist and expert, and the various types of decision maker. A scientific foundation is necessary for credibility, but the interpretation and analysis carried out by an SOER program are essential if scientific knowledge is to be transformed into meaningful information and used in decision making. Within this context, the more specific niche for SOER will depend more on circumstances unique to the reporting region in question. A comprehensive national report may be the initial focus to provide a credible benchmark for future efforts which could be increasingly based on policy-relevant indicators. If sector agencies have established environmental or sustainable development reporting themselves, it makes little sense for the environmental reporting agency to duplicate this analysis. A more integrated, ecosystem approach looking at linkages between sectors could then be more appropriate for the overall reporting program.

- To be successful, SOER should rely on a **family of products** designed to meet diverse user needs. A periodic comprehensive global or national report on its own is not sufficient for a viable reporting program which strives to increase public awareness and influence policy decision making. The product range should include wherever possible maps, audio-visual and electronic products, as well as traditional print publications. It is also important to disseminate information on a continual basis. This can be accomplished directly or through the use of intermediaries such as the media and education community. Chapter VII elaborates on these aspects of environmental reporting.

# II INSTITUTIONAL CONSIDERATIONS

## 1 Introduction

In this section, we explore some of the institutional questions related to state of the environment reporting. An early decision associated with the establishment of an SOER program will be the policy and legislative requirements. A second consideration relates to the appropriate institutional setting and scope for the reporting agency. Once in operation, the strategic direction of the program will require continuous attention if it is to remain dynamic and responsive to needs and external influences. The contribution of partners and the role of capacity building are also discussed in this section.

These institutional aspects should be considered in the context of the SOER program as a whole. Obviously, the institutional characteristics will influence the conceptual thinking, the emphasis on database development, and the product lines of any particular program. Thus, the information below should not be viewed in isolation, but in conjunction with the other sections of this Source Book.

In addition, it is important that the institutional arrangements for SOER are consistent with the broader institutional setting of the country or region. Some countries have a tradition of scientific investigation, systematic data gathering, and planning. In such cases, environmental information may well be adequately developed and organized. In other countries, this may not be the situation. The institutional arrangements to support sustainable development may be at a relatively early stage of evolution. Responsibility for environmental information may be scattered and uncoordinated. With such contrasting externalities, it is essential to recognize that the cultural setting, overall institutional development, and information requirements are closely linked.

## 2 The Support of Legislation

In the continuing effort to strengthen environmental institutional mechanisms, many countries have taken the step to institutionalize reporting on the state of the environment through legislative provisions (Comolet, 1992; Economic and Social Commission for Asia and the Pacific, 1994; The Mekong Secretariat, 1995). Since the late 1980s and following the impetus of UNCED, environmental legislation has broadened in perspective from the traditional protection and regulation approach to an emphasis on sustainable development. Consequently, new legislation frequently provides policy and program thrusts related to, for example, the generation of national strategies for sustainable development, the improvement of public access to information, and the adoption of additional instruments, such as environmental impact assessments. Thus, SOER frequently forms an important component of such legislative provisions.

A specific legislative provision is not absolutely necessary for the implementation of a successful reporting program, although the activity must, of course, be contained within the general framework of a country's legislative competence. A sound legislative base, however, does demonstrate political commitment and provides a measure of stability and continuity beyond the initial political announcement to establish a reporting program.

If the opportunity arises to provide or strengthen the legislative foundations for SOER, a number of dimensions should be considered for inclusion. The adoption and specific form of these elements will need to be determined against national circumstances and

characteristics. The legislative provisions can be used to shape and define the scope of the reporting program. The most relevant dimensions from a legislative perspective would:

- establish the citizen's right to environmental information;
- define the reporting program's objectives;
- define the institutional mechanism for reporting;
- discuss the linkages to other levels of government; and
- determine consultative mechanisms.

The legislation should clearly establish the government's responsibility to report on the state of the environment in the context of the citizen's right to know. The objectives set by the legislation will determine the emphasis on raising the public's awareness and contributing to sustainable development decision making. The objectives could stress improved access to information, indicate that the results of state of the environment assessments will be tabled for discussion in Parliament, used in priority setting and budget formulation, or used to provide guidance for sustainable development strategies. Some examples of the legal underpinnings for SOER are presented in Box 2-1 for a sample of jurisdictions.

A variety of institutional options are available to deliver a reporting program. Fundamentally, the choice rests between an existing government department or the creation of a special agency responsible for reporting and environmental information. This aspect of legislation could also cover the extent of collaboration between government agencies who can contribute to the reporting initiative. In certain cases, it may be fitting for the legislation to establish a special partnership between the national statistical authority, national environmental monitoring programs, and the reporting agency. Similarly, it would be appropriate for the legislation to discuss environmental reporting among various levels of government. A national reporting agency, for example, could play a catalytic and supporting role in the developing of reporting at sub-national and local levels. In addition, the legislation could be used to encourage data sharing and harmonization of reporting initiatives. Finally, the legislation can set the stage for external consultation and participation, including the use of advisory bodies.

Obviously, legislation only provides the overall institutional framework for reporting. More elaboration is required for operational decisions concerning several of these features. This information is provided below.

## 3 Institutional Setting

What is the most appropriate institutional setting for an SOER program? What type of organization will allow a reporting program to meet its mandate most effectively and efficiently? A key question concerns the placement of an SOER agency or group in relationship to policy units within government. To achieve credibility, the development of SOE assessments should be conducted with maximum independence and separation from operational programs. However, good linkage and communication are essential with policy processes so that the reporting results can be fully used to facilitate sound decision making.

**BOX 2-1**

**THE LEGISLATIVE AND REGULATORY PROVISIONS FOR STATE OF THE ENVIRONMENT REPORTING**

**Legislation to Support SOE**

**Japan:**

- The Government shall submit annually to the Diet a report on the state of the environment and the policies implemented with regard to environmental conservation.

- The Government shall make and submit annually to the Diet a document explaining the policies the Government is going to implement considering the state of the environment as described in the above report.

*Japan Basic Environment Law, Law No. 91, Article 12, 1993.*

**Mexico:**

- The National Ecology Commission will present to the Federal Executive a detailed report of the overall situation in Mexico regarding the state and protection of the environment.

*Mexico General Law of Ecological Equilibrium and Environmental Protection, Article 12, 1988.*

- The Secretary of the Environment, Natural Resources, and Fisheries will be responsible for the quality of the environment; and the establishment and promotion of information systems including those that: a) monitor the atmosphere, soils, and water bodies under federal jurisdiction; and b) provide inventories of natural resources and wildlife. This responsibility will be completed in cooperation with state and local authorities, research and academic institutions, and other pertinent organizations.

*Mexico Organic Law of the Public Administration, Article 32, Section XIV, December 1994.*

**The Netherlands:**

- The Minister shall ensure that at least once every four years a report is drawn up describing the situation with regard to the environment in the Netherlands; it shall be submitted to the States General and made accessible to the public.

- For the purpose of drawing up reports as referred to in subsection one, preparing environmental policy plans, and drawing up environmental policy programmes, government bodies shall provide each other on request with all information and data in their possession that may reasonably be required for this purpose.

*Netherlands Environmental Management Act, Section 4.2, January 1995.*

**Sri Lanka:**

- The powers, functions and duties of the Central Environmental Authority, shall be to:

  - publish reports and information with respect to any aspects of environmental protection and management;

  - provide information and education to the public regarding the protection and improvement of the environment.

*Sri Lanka National Environmental Act, Part II, Sections 10K and 10N, 1988.*

**BOX 2-1 (Cont.)**

**Vietnam:**

- The National Environmental Agency is required to submit regular reports on environmental conditions to the National Assembly.

*Vietnam Environmental Protection Law, December 1993.*

**Yukon Territory, Canada**

- The Government of the Yukon shall report publicly on the state of the environment.
- The Minister shall prepare and submit to the Legislative Assembly a Yukon State of the Environment Report within three years of the date this section comes into force and thereafter within three years of the date of the previous report.

*Yukon Environment Act, Sections 47 (1) and 48 (1)*

**Environmental Information Provisions under Environmental Agency Legislation**

**European Community:**

- This Regulation establishes the European Environment Agency and aims at the setting-up of a European environmental information and observation network.
- The Agency shall:
  - establish, in cooperation with Member States, and coordinate a network of national focal points and topic centres to facilitate the collection, processing and analysis of data;
  - provide the Community and the Member States with the objective information necessary for framing and implementing sound and effective environmental policies;
  - record, collate and assess data to enable it to describe the present and foreseeable state of the environment, to draw up expert reports on the quality, sensitivity and pressures on the environment within the territory of the Community, to provide uniform assessment criteria for environmental data to be applied to all Member States;
  - focus, in particular, on transfrontier, plurinational and global phenomena;
  - help ensure that European environmental data are comparable and, if necessary encourage improved harmonization of methods of measurement;
  - promote the incorporation of European environmental information into international environmental monitoring programmes such as those established by the UN;
  - ensure the broad dissemination of reliable environmental information, including the publication of a report on the state of the environment every three years;
  - stimulate the development and application of environmental forecasting techniques so that adequate prevention measures can be taken; and
  - cooperate with institutions and programmes such as Joint Research Centre, the Statistical Office, and the Community's environmental research and development programmes.

Adapted from: *Council of the European Communities Regulation No. 1210/90, May 7, 1990.*

**BOX 2-1 (Cont.)**

**Uganda:**

- The legislation establishes a body called the National Environmental Management Authority.
- With respect to environmental information, the Authority shall:
  - gather information on the environment and natural resources;
  - have access to any data collection on the environment and natural resources;
  - analyze information and disseminate information to public and private users;
  - carry out public information and education campaigns in the field of the environment;
  - exchange information with other Ugandan, foreign, international and non-government agencies;
  - coordinate the management of environmental information in the lead agencies;
  - advise Government on existing information gaps and needs;
  - establish guidelines and principles for the gathering, processing and dissemination of environmental information, in consultation with the lead agencies;
  - liaise with the district environment committees and district environment officers regarding environmental information;
  - publish a State of the Environment Report every two years which, in addition to other matters, will specify the main activities of the Authority and the lead agencies regarding the protection of the environment; and
  - publish such other publications as necessary for public education on the environment.

Adapted from: *Uganda National Environment Statute, Section 87, 1994.*

Countries have successfully tried various institutional models to deliver reporting programs. Basically, national governments can:

- support a regional institution with a reporting mandate.
- use an existing government department;
- establish an independent agency at arm's length to government;

The balance between national and regional reporting must be decided by national governments, but there are many precedents where SOER is completed at both national and regional levels. The first option provides the opportunity for national governments to contribute to reporting on environmental issues in a broad regional or continental context. This is particularly appropriate for shared issues or common ecosystems. Of course all member governments can contribute to the global reporting and assessment program of UNEP (see United Nations Environment Programme, 1990, 1993b, and 1994b).

Many regional organizations support SOER programs (See Table 2-1). ESCAP has a well-established program and has completed its third regional report. Various regional organizations in the Asia-Pacific region are engaged in supporting and strengthening SOE reporting at both national and regional levels. These include the South Asia Co-operative Environment Programme (SACEP), the South Pacific Regional Environment Programme (SPREP), the Association of South East Asian Nations (ASEAN). Cooperation in Southern Africa through the Southern African Development Community (SADC) has recently produced the region's first SOE report (Southern African Research and Documentation Centre et al, 1994). In Europe, most countries complete SOE reports on a regular basis and contribute to various regional reporting programs such as those of the Commission of European Communities and the Nordic Council. OECD encourages its members to report on the state of the environment, while producing periodic reports for the total membership. In the Americas, the Organization of American States (OAS) has proposed the development of an SOE Atlas, while the Economic Commission for Latin America and the Caribbean (ECLAC) has assisted governments to produce national SOE reports. In addition, the North American Commission on Environmental Cooperation (NACEC) encourages member countries to produce regular SOE reports while future reporting will be completed for North America as a whole.

The other two options above provide the basic choices for national reporting: either through an existing government department or a relatively autonomous arm's length agency. Some of the potential advantages and disadvantages associated with these two options are presented in Table 2-2). If it is decided to use an existing government agency, the choice usually rests between the environment department, a natural resource management department, or the statistical agency. Such a choice minimizes the creation of new organizations and builds upon existing capabilities. However, the risk is that sectoral interests will shape the SOE reporting products to favour the status quo and mute any criticism or pressure for change. On the other hand, working within government can establish greater collaboration and access to otherwise unavailable or current data. In times of fiscal restraint and tight budgets, giving an existing agency responsibility for SOER can represent an attractive option. In fact, reorganization to amalgamate existing units can strengthen the overall reporting function.

If the reporting group is situated within a government department, efforts can still be made to maximize independence and separation from operational programs. Relatively independent groups, such as an information centre can be established, statistical agencies tend to be relatively independent and removed from undue influence, while a public advisory committee can be regarded as a mechanism to guard balanced reporting through continuous consultation with representatives of various client groups.

The use of an autonomous, relatively independent agency such as a council, research organization or crown corporation[1], can create considerable profile for environmental information and provides the opportunity to adopt fresh, innovative approaches which may be more successful at meeting the public demand for balanced and independent information. Such an arrangement provides a focus for reporting rather than lodging the activity in the midst of a larger organization. Being at arm's length, an agency would be less susceptible to influence by vested interests, and would satisfy credibility and accessibility requirements. Being outside standard bureaucratic structures may allow the specialized reporting agency to respond more quickly and effectively to information user needs. In addition, independence would encourage the involvement of a greater cross-

[1] Government-owned company.

## TABLE 2-1

## REGIONAL ORGANIZATIONS AND STATE OF THE ENVIRONMENT REPORTING

| Organisation/ Members | Mandate for SOE Reporting | SOE Activity / Emphasis |
|---|---|---|
| ESCAP<br><br>(Economic and Social Commission for Asia and the Pacific)<br><br>Members: 47 Asian and Pacific countries<br><br>Afghanistan, American Samoa, Australia, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Cook islands, Fiji, French Polynesia, Futuna, Guam, India, Iran, Indonesia, Japan, Kiribati, Korea Rep., Lao PDR, Malaysia, The Maldives, Mongolia, Myanmar, Nauru, Nepal, New Caledonia, New Zealand, Niue, Norfolk Islands, Pakistan, Papua New Guinea, Phillipines, Pitcairn Island, Singapore, Sri Lanka, Solomon Islands, Tuvalu, Thailand, Tokelau, Tonga, Trust Territory of the Pacific Islands, Vanuatu, Vietnam, Wallis, Western Samoa. | Commission session, 1987:<br><br>• Request for a second report on the state of the region's environment for the purpose of establishing a better conceptual link between economic development and environmental quality. | • Two regional SOE reports, 1985 and 1990, have been completed; a third is in preparation for publication in 1995.<br><br>• Use national Focal Points.<br><br>• Initiating work on indicator development. |
| ASEAN<br><br>(Association of South East Asian Nations)<br><br>Members: 6 South East Asian countries<br><br>Brunei Darussalam, Indonesia, Malaysia, Phillipines, Singapore, Thailand | Strategic Plan of Action, 1994,<br><br>Strategy 3:<br><br>• Strengthen the knowledge and information database on environmental matters.<br><br>• Establish mechanism for the preparation of periodic reports on the state of the region's environment. | • First regional SOE report initiated.<br><br>• Emphasis on cooperation between countries and capacity building for assessment and reporting. |
| SACEP<br><br>(South Asia Co-operative Environment Programme)<br><br>Members: 9 South Asian countries<br><br>India, Sri Lanka, the Maldives, Nepal, Bangladesh, Pakistan, Bhutan, Iran, Afghanistan. | Meeting on Environment Reporting, Governments in South Asia Region, 1994:<br><br>• Unanimous adoption and agreement to establish a national database on state of the environment reporting. | • First regional SOE report to be published in 1995.<br><br>• Emphasis on capacity building and developing SOE databases at the regional and national levels. |

| | | |
|---|---|---|
| SPREP<br><br>(South Pacific Regional Environment Programme)<br><br>Members: 21 South Pacific countries and territories<br><br>American Samoa, Cook Islands, Fiji, French Polynesia, Futuna, Guam, Kiribati, Nauru, New Caledonia, Niue, Norfolk Islands, Papua New Guinea, Pitcairn Island, Solomon Islands, Tokelau, Tonga, Trust Territory of the Pacific Islands, Tuvalu, Vanuatu, Wallis, Western Samoa | Regional Conference of the Human Environment in the South Pacific, 1992:<br><br>Action Plan:<br><br>• To further assess the Pacific environment.<br><br>• Gather and disseminate information on the environment. | • One regional SOE report has been completed.<br><br>• Emphasis on national and regional capacity building and coordination with respect to environmental information. |
| SADC<br><br>(Southern African Development Community)<br><br>Members: 12 Southern African countries<br><br>Angola, Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe | SADC Regional Workshop, September 1994:<br><br>Three keys areas of the assessment and strategy for implementing a Regional Support Programme:<br>• Harmonization of environmental data.<br><br>• Timely preparation of SOE reports.<br><br>• Provision of services, including training. | • First regional SOE report completed in 1994.<br><br>• Have established the India Musokotwane Environment Resource Centre under the Communicating the Environment Programme.<br><br>• Emphasis on regional collaboration. |
| OECD<br><br>(Organisation for Economic Cooperation and Development)<br><br>Members: 25 countries<br><br>Austria, Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Iceland, Italy, Japan, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, USA | Ministerial Council Meetings, May 1979 and January 1991:<br><br>• Recommends that Member countries prepare periodic national reports on the state of the environment and changes over time.<br><br>• Instructs the OECD Environment Committee to prepare and disseminate a periodic report on the state of the environment of Member countries; and develop core sets of indicators. | • Three SOE reports for OECD as a whole have been completed in 1979, 1985 and 1991.<br><br>• A core set of environmental indicators have been proposed and two environmental indicator reports have been released.<br><br>• A SOE database has been developed from biennial questionnaires and they have been published as a compendia. |
| Nordic Council<br><br>Members: 5 countries<br><br>Denmark, Finland, Iceland, Norway, Sweden | The Nordic Council of Ministers , 1989:<br><br>• Adoption of an intention in the Nordic Environment Program of publishing regular reports on the state of the environment in the Nordic Countries. | • The first report was completed in 1993.<br><br>• Emphasis on cooperation among the Parliaments and Governments of the Nordic countries. |

| | | |
|---|---|---|
| NACEC<br><br>(North American Commission for Environmental Cooperation)<br><br>Members: 3 countries<br><br>Canada, Mexico, USA | North American Agreement on Environmental Cooperation as part of the NA Free Trade Agreement (NAFTA), October 1993:<br>• Member countries are to complete and make public SOE reports.<br><br>• Periodic trilateral SOE assessments.<br><br>• Development of common environmental indicators | • The commission has been recently formed.<br><br>• North American Workshop on Environmental Information held. |

section of stakeholders in the reporting process, including other levels of government and non-governmental institutions. A new agency, however, can encourage rivalries and some duplication with existing agencies. In addition, access to data and information from government departments, other than those already published, may be more difficult to obtain, unless access is guaranteed by legislation.

The scope of any SOER program will obviously depend on the level of its budget and human resources. A minimum program will be able to realize the publication of a periodic national or regional SOE report, relying on easy-to-access data, limited assessment and consultation, and traditional approaches. Strategic partnerships offer one possibility of maximizing the effectiveness of a limited budget. Larger programs can offer a wider range of products based on a greater degree of collaboration and consultation, provide integrated database support, and continuous reporting using more innovative methods. With additional resources SOER programs can become active in support of global, international and local reporting; and invest in monitoring and surveys or research and development to solidify the conceptual basis for reporting. Optimally resourced programs could complement the above areas through the development of integrated ecosystem monitoring to fill data gaps; and information network development to provide a one-window clearing house for environmental information.

A number of approaches, none of which are mutually exclusive, can be taken to complete the reporting task itself. In all cases, however, people with interdisciplinary training and experience are most appropriate for SOER work. If resources are very limited, the choice rests between the use of consultants and the dedication of one or two staff members to SOER. Consultants can be useful in realizing SOE products where staff resources are the constraint. Consultants, however, cannot carry a successful SOER program on a continuous basis where capacity building, maximum coordination and cooperation amongst agencies, and stakeholder consultation are valued outcomes. Where staff resources are available, but financial constraints critical, the dedication of one or two staff members can improve the reporting results, but without additional support from the agency, the reporting effort will typically be rather isolated without the benefits of wider collaboration and consultation.

Other options would increase the complexity and resource requirements of the task, but widen the involvement and commitment (Campbell and Maclaren et al, 1995). A lead agency could coordinate the delivery of a reporting program through support to a working group or secretariat. This team approach would maximize the contribution and participation of all relevant departments within one agency or interdepartmentally across

**TABLE 2-2**

**BASIC INSTITUTIONAL MODELS FOR STATE OF THE ENVIRONMENT REPORTING**

| Type of Agency | Advantages | Disadvantages |
|---|---|---|
| EXISTING GOVERNMENT DEPARTMENT | * Rapid start-up<br>* Limits proliferation of special agencies<br>* Existing regional networks<br>* Greater collaboration within government<br>* Access to data and information | * Not recognized as independent<br>* Limited public profile<br>* Less stakeholder involvement<br>* Tends to protect the status quo |
| ARMS LENGTH AGENCY | * Independent<br>* High profile and visibility<br>* Potential for innovation and greater efficiencies<br>* Links to non-government stakeholders and scientists | * High transmission costs<br>* Requires formal powers of access to data<br>* Unbalanced stakeholder influence<br>* Lack of regional networks |

Adapted from: Environment Canada, 1992a.

government. This would require time to solidify into a cohesive reporting mechanism with a common vision and objectives particularly using the multi-agency approach. Without special attention to external consultation and input, these options could be prone to providing a rather conservative reporting response, not totally meeting the expectations of clients.

Finally, if resources permit, a dedicated, intersectoral process involving all community sectors could be established to advance both the substance and process required for SOER. Such a process represents the ideal long term option to support continuous reporting, maximize capacity building, and promote collaboration and participation both within and external to the government structure. Some of the advantages and disadvantages of these options are summarized in Table 2-3.

## 4 Strategic Planning and Program Evaluation

Strategic Planning

Strategic planning addresses the future direction of a SOER program. It can provide a structured and formalized process to facilitates program shifts to meet changing circumstances especially those of external origin. New reporting initiatives at regional and sub-national levels, for example, may represent an opportunity for a national program to

**TABLE 2-3**

**ALTERNATIVE APPROACHES FOR COMPLETING SOER**

| Process | Advantages | Disadvantages |
|---|---|---|
| **Unidisciplinary** | • Process is simple<br>• Internal communication and review process is easy | • Scope of SOE may be narrow<br>• Interest by other disciplines, agencies and sectors may be low |
| **Intradepartmental** | • Involves multi-disciplines within one agency<br>• Facilitates shared vision of environmental issues | • Involves more resources and time |
| **Interdepartmental** | • Opportunity for diverse agencies to coordinate environmental reporting<br>• Access to data collected by various agencies<br>• Broadens support of product and commitment for action | • Coordination more difficult and time consuming<br>• Different agency mandates may make it difficult to agree on approach and balance of the product |
| **Community Based** | • Broad opportunity for all societal sectors to participate<br>• Maximum support of product and commitment for action | • Coordination, communication and review is complex and time consuming<br>• Different conceptual backgrounds may make it difficult to reach consensus on approach and scope |

Adapted from: Campbell and Maclaren et al, 1995.

stress more innovative approaches that are complementary to the total effort. The result of capacity building across government departments provides expanded opportunities for more effective and collaborative reporting. As the public becomes more aware of environmental issues and environment-economy interdependence, different product lines may be required to satisfy their needs.

Within the legislative and institutional context, strategic planning defines success, and shapes and guides what a reporting program is, what it does, and why it does it (Bryson, 1988). If conducted in an open and participatory process, strategic planning can facilitate communication, accommodate divergent interests and values, and encourage consensus and team commitment. Strategic thinking is desirable to ensure that the SOER program stays relevant, continues to meet user needs, and occupies an appropriate niche within the total environmental information field.

A documented strategic plan provides a common point of reference to everyone involved in an SOER program. Common elements of such a plan would include an outline of the current situation, a mission statement focusing on the mandate and role of the program, a vision of program success, specific objectives, and strategies for achieving the objectives. Pertinent strategies for an SOER program could cover partnerships and collaboration, the range and type of products, domestic and international data harmonization, reporting frameworks, research needs, consultation, relationship to policy decision making, and dissemination of information. As an example, a summary of the existing strategic framework which guides the Australian SOER program is provided in Box 2-2.

**BOX 2-2**

**THE STRATEGY FOR STATE OF ENVIRONMENT REPORTING IN AUSTRALIA**

**Background**

The need for national environmental reporting was recognized in Australia in the 1970s and 1980s. The first Australian SOE reports were published in 1986 and 1987, but no continuous reporting program or organization was established. However, in December 1992, the Prime Minister committed the Australian Government to establish a regular SOER program in order to meet the reporting requirements of UNCED's Agenda 21, international conventions, international organizations, and its own National Strategy for Ecologically Sustainable Development. Public comment on a discussion paper and a national consultative workshop were used to establish a strategic framework for a state of reporting system to meet Australian needs. This SOE strategic document was released in early 1994.

**The Strategy**

In establishing the strategic framework, the document provides a clear **purpose** for SOER, provides **principles** to guide activities, specifies a series of **objectives** and discusses their achievement, and outlines a mechanism for regular **program evaluation**. In addition, the strategic framework:

- discusses the **role of environmental information** in a national and global context;
- profiles the **clients** and outlines **potential products** of the program;
- outlines the **coordination and partnerships** with Commonwealth agencies, State, Territorial and local government, and community, industry and research groups;
- defines the **approach** to SOER based on the pressure-state-response model and techniques related to **issue selection**, establishment of **baseline information, data management** and **indicator development**, the establishment of **predictive capacity**, and **system evaluation**; and
- addresses **external consultation** and advice via an SOE Advisory Council, the use of reference groups, and the public in general.

**The Objectives**

The **objectives** established for an SOER program are particularly relevant to setting its strategic direction. The scope of SOER objectives is well illustrated by the Australian strategic framework. In summary, the objectives are to:

- regularly provide the Australian public, its governments and decision makers with accurate, timely, and accessible information about the conditions of and prospects for the Australia environment;
- increase public understanding of the Australian environment;
- help decision makers to make informed judgements about the broad environmental consequences of social, economic, and environmental policies and plans;
- provide early warning of potential problems;
- report on the effectiveness of environmental policies and programs including progress towards achieving environmental standards and targets;

**BOX 2-2 (Cont.)**

- contribute to the assessment of Australia's progress towards achieving ecological sustainability, including protecting biological diversity and maintaining ecological processes and systems;
- facilitate the development and reporting of a national set of environmental indicators;
- create a mechanism for integrating environmental information with social and economic information;
- identify gaps in Australia's knowledge of environmental conditions and trends and recommend research and monitoring strategies to fill these gaps; and
- fulfil Australia's international environmental reporting requirements.

The first three objectives can be considered as fundamental to any SOER reporting program. The others can be viewed as supplemental and included or emphasised according to national and regional circumstances.

Source: Australia Department of the Environment, Sport and Territories, 1994.

Program Evaluation

Evaluation of the total program and of major products can be used to guide the strategic direction of an existing reporting organization. The main objective of such evaluations is to learn from experience. The timing of evaluations is significant. Regular periodic evaluations are appropriate for the program as a whole, while those directed at major projects should be completed soon after dissemination, but allowing for an initial wave of client use. The evaluation should obviously consider both positive and negative aspects. The strong points can be reinforced and built on in future work, while deficiencies can be addressed and improvements to products and processes incorporated as the opportunity arises (Environment Canada, 1993c).

In program and project evaluation, it is common to assess four aspects:

- efficiency assesses the resources (time, money, and people) used in the program or project.
- effectiveness provides a measure of the results actually achieved against the objectives that were planned or anticipated.
- relevance addresses the degree to which the results obtained correspond to the actual needs.
- impact assesses the long term effects of the program in terms of broad societal objectives such as awareness raising, contribution to understanding, and usefulness for decision making.

Under **efficiency**, the program objectives or product would be examined to see if the process to achieve the results could be achieved with less effort or cost. For each aspect of the program or stage in the production process, the evaluation will try to determine the variance between predicted and actual costs, and the potential for cost savings. An

examination of the human resources and organization will provide insights into staff numbers, quality, and dynamics. The cause and consequences of any delays should be evaluated against project schedules.

While efficiency relates primarily to process, effectiveness and relevance are concerned more with the results and outputs of reporting programs. The degree of awareness of the program and its products by the public, or targeted clients, such as policy decision makers, is a good measure of **effectiveness**. Such a measure needs to be judged against other influencing factors, however, such as size and longevity of the organization. The demand for products, either directly or via the mass media, represents another effectiveness criteria. This becomes more meaningful if clients have to make an effort to obtain products, through purchase or specific request. In addition, the distribution runs of SOE products can be compared to similar outputs released previously or in other regions. Such data represents a first-order indicator of the public's interest in SOE products and the marketing approaches employed.

To evaluate **relevancy**, external response from users is required to determine the degree and type of use, the degree of client satisfaction, the credibility of the information, and the extent to which the program or products meet actual needs. Such feedback can focus both on the substantive aspects, the timeliness, and the presentation vehicle and its format. Media analysis, user surveys, client consultations, and commissioned reviews of products are examples of techniques that can be used to evaluate relevancy.

The measurement of **program impact** in an objective way is difficult and requires a longer term perspective[1]. This aspect is used to answer whether fundamental changes and improvements in society have occurred. In the context of an SOER program, the impact would be most appropriately measured in terms of the influence on policy and investment decision making; public awareness and education; public opinion; state of knowledge about ecosystems and sustainable development; and the supply, demand, and type of environmental information.

An evaluation can be accomplished in a number of ways. The administrative aspects associated with costs, personnel, schedules, marketing and communication can be assessed. Feedback from the staff, consultants and other participants associated with the program or the product can provide useful internal insights. External opinions can be solicited from user surveys, consultations with major client groups, assessment of media coverage, or commissioned reviews. An example of the tools used to evaluate a major SOE product is provided in Box 2-3.

## 5 Partnerships and Consultation

Partnerships and consultation are two essential ingredients of a successful SOER program. SOER, as a cross-cutting, multi-dimensional process which involves many disciplines in the natural and social sciences, demands such a collaborative and participatory approach. Such an approach was recognised and supported by UNCED, and is currently being widely adopted even by countries which do not have a tradition of open and inclusive participation.

A partnership is defined as an undertaking completed by two or more cooperating parties. It is a relationship that consists of shared or compatible objectives with an acknowledged

[1] This is an aspect of SOER that requires additional research to document program experiences.

**BOX 2-3**

**EVALUATION OF CANADA'S 1991 NATIONAL SOE REPORT**

| Evaluation Tools | Function and Purpose |
|---|---|
| Efficiency<br>Analysis of Costs and Schedules: | An internal analysis of the costs of preparing the report in terms of time, staff and dollars. For each step in the production process, an attempt was made to determine the variance between actual and predicted costs, and to examine the potential for minimizing these in the future. |
| Feedback from Participants: | Through the use of interviews or questionnaires, feedback was obtained on each stage of the production process. This approach was required to complement the analysis of costs and timeliness, explain variances, and determine ways to streamline and improve the process for the future. |
| Effectiveness and Relevance<br>Analysis of Sales: | Sales statistics were collected and analyzed as a first-order indication of the public's interest in the report. Sales were examined from a marketing perspective by examining distribution over time, by purchaser category, by region and by sales outlet; and the impact of specific promotional activities. |
| User Survey[1]: | A questionnaire was employed to obtain information by user category on client needs and satisfaction. Questions covered both the substance of the report and the presentation format. Together with sales statistics, this was the principal method of obtaining quantitative data for the evaluation. |
| Media Coverage: | Media coverage was monitored and analyzed to provide: a) information on the use of the report by a specific audience, journalists; b) an indirect measure of public interest in the report; c) a measure of the effectiveness of the communications plan. |
| Provincial/Territorial Consultations: | In a round of consultations on the SOE Reporting program in general, specific questions on the 1991 report and future national reports were included to obtain feedback from provincial and territorial governments. |
| Commissioned Reviews: | Experts from various professional categories and disciplines representative of the target audience were commissioned to critique the report according to guidelines prepared for the evaluation. Questions included a focus on strengths and weaknesses, and how deficiencies could be addressed. Reviews provided qualitative data for more in-depth analysis of user needs. Reviewers were selected from the following categories:<br>- government and para-government policy decision makers;<br>- environmental groups; - scientists;<br>- educators; - industry & business representatives;<br>- media representatives; - environmental consultants. |
| Advisory Committee Review: | All current members of the Advisory Committee on SOE Reporting, and some past members who had been closely involved with the report in its earlier stages, were asked to review the report using guidelines similar to those prepared for the commissioned reviews. |

Adapted from: Table 1, Environment Canada, 1993c.

[1] Note: A convenient way to collect such user feedback is via a questionnaire insert in SOE products.

distribution of roles and responsibilities among participants. The partnership can be formal or informal, contractual or voluntary. Such cooperation implies joint investment of resources such as time, money, or material; and shared risk-taking and benefits. Consultation represents an interactive and iterative process that seriously elicits and considers the ideas of people and encourages their involvement in establishing the strategic direction, priority issues, and design and delivery of products and programs (Environment Canada, 1992b).

An SOER organization needs to be proactive in its support of partnerships and consultation. Credible environmental information has a multitude of different uses. Environmental issues tend to be complex and can be perceived from a multiplicity of perspectives or from a variety of scales. The integration of environment and development data compels the involvement of a variety of experts. As with sustainability, no one person can have the depth and range of knowledge and understanding required for comprehensive reporting. The coordinated approach to SOER whereby a **collective** assessment results can be analogously compared to an orchestra where the conductor harnesses all the different players and instruments together to produce harmonious music.

The views of decision makers and the public need to be reflected in an SOER program to ensure relevance and appropriateness. Scientists and data holders need to be consulted and closely involved in SOER to achieve credibility and objectivity. Participation by society's various interest groups will help achieve acceptance and use of the results of the state of the environment assessment. In these contexts, the principle purposes of partnerships for SOER are typically to:

- identify information needs and sources;
- specify protocols for collaboration, including data and information sharing;
- identify shared reporting and cost-saving opportunities; and
- establish cost-sharing arrangements for data collection and management.

Partnerships particularly relevant to the Australian SOER program, for example, included the acquisition of strategic advice and direction, the identification of environmental issues requiring reporting; the harmonization of data collection and management; the development of indicators and cooperative products; the satisfaction of special interest group needs; capacity building; and the provision of expert reviews of draft products (Australia Department of Environment, Sport and Territories, 1994). Some examples of the types of partnerships and the suggested mechanisms for their implementation are provided in Table 2-4.

This coordinating concept of an SOER organization implies a central node for reporting which depends on a network of institutions and individuals to enable it to carry out its reporting mandate (See Figure 2-1). It does not mean that every function, such as monitoring, data management, or even product production, is highly centralized. Such a decentralized networking approach can be cost effective; minimize functional duplication; improve access, harmonization and integration of data; contribute to institutional strengthening; and provide mutual benefit and recognition.

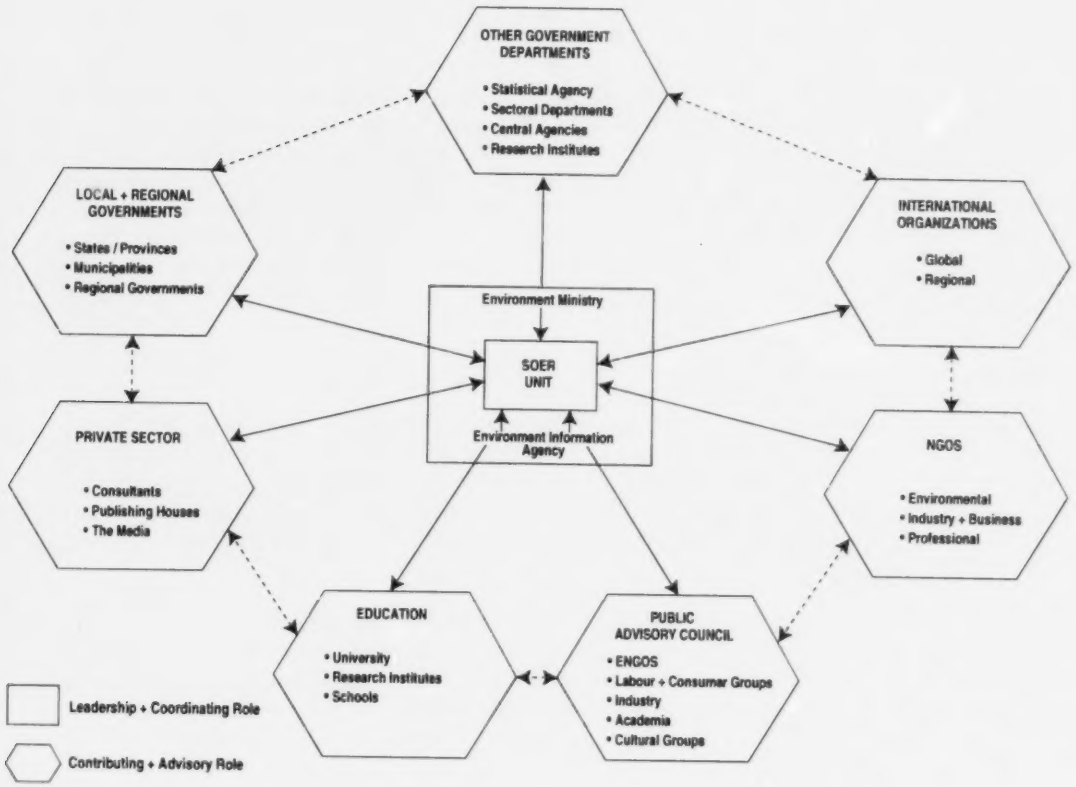
**TABLE 2-4**

**TYPES OF PARTNERSHIPS**

| Purpose | Mechanism |
|---|---|
| Strategic Advice | Advisory Council<br>Discussion Paper<br>Workshop for Feedback |
| Program Evaluation | Advisory Council<br>External review and Consultations |
| Program Optimization and Harmonization | Partner Committees<br>Focal Points<br>Memoranda of Understanding |
| Data Access and Management | Focal Points<br>Formal Agreements and Protocols<br>Networks and Communication Linkages |
| Product Design, Development, and Dissemination | Advisory Council<br>Reference Groups<br>Peer Review |
| Product Evaluation | User Surveys<br>Commissioned Critiques |
| Joint Projects | Collaborating Centres<br>Task Force/Working Groups<br>Letters of Agreement<br>Consulting Contracts |
| Access to Scientific Expertise | Expert Networks<br>Task Forces<br>Peer Review |
| Indicator Research and Development | Task Force<br>Scientific Network<br>Contracts with Research Institutes<br>International Fora |
| Capacity Building | Focal Points<br>Letters of Agreement<br>SOE Courses and Training<br>Regional Networks |

To illustrate the role of partnerships and consultation in SOER, three contrasting examples are outlined in Boxes 2-4 to 2-6. In Box 2-4, the extensive collaboration used to produce a baseline comprehensive SOE report for Southern Africa is discussed. In the second box, Box 2-5, the terms of reference for a Public Advisory Committee on SOER is profiled. While Box 2-6 highlights the potential contribution of the private sector to SOE product development.

**Figure 2-1**
**Network of Partnerships for National State of the Environment Reporting**




Adapted from Kerr, 1988

## 6 Institutional Capacity Building

Capacity building in the acquisition, management, and reporting of environmental information is critical to many countries if they are to make sound decisions on sustainable development actions. It may be necessary to foster a climate and culture of using environmental information for decision making. The strengthening of institutions, through human resource development, training, and technology transfer, can be important prerequisites to facilitate improved understanding of complex environment and socio-economic issues, the maximum use of available data, and enhanced environmental assessment and reporting at national and international levels.

Close partnerships will be necessary between national governments, regional institutions, the donor community, and UN Earthwatch agencies to achieve cohesive, complementary, and effective capacity building in environmental information development for SOER. Partnerships with local and regional governments, universities and research centres, non-government organizations, and the private sector can also be used to complement a capacity building program. With respect to environmental information, capacity building will result in improved access, management, and use of available data; the development of national and regional networks for data sharing and integration; and improved quality and delivery of information for reporting.

**BOX 2-4**

**SOE COLLABORATION IN SOUTHERN AFRICA**

**Background**

In the early 1990s, the Southern African Development Community (SADC), in cooperation with UNEP and the German Technical Cooperation Agency, began to assess the level of environmental information system development in the Southern African region. The countries who currently make up the region include: Angola, Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe. The need for a regional SOE report was recognised as a key element in the strategy and program to strengthen the development and use of environmental information for awareness raising and to provide a better foundation for natural resources management, and improved environmental policies and legislation.

**The Collaboration**

The decision to produce a regional SOE report was taken in 1991. In the three years taken to produce the report, *State of the Environment in Southern Africa,* many people contributed ideas, time and effort in a collective process to give the report its resulting substance and authority. The three sponsoring partners of the Communicating the Environment Programme (CEP) are the Southern African Research and Documentation Centre (SARDC); IUCN; and the Environment and Land Management Sector (ELMS) of SADC.

The initial period of report production focused on data and information collection; and the development of a computerized information database of bibliographic references and abstracts, and experts and contacts of environmental organizations. This base facilitated the development of a draft skeleton for a report which included a chapter outline and the main issues to be covered. In addition, the organizers had a pool of regional talent to call on for advice and direction.

Subsequently in May 1993, five environmental specialists from each member country in Southern Africa were invited to attend a conference to discuss the report, including the outline, the process being used, and the adequacy of the available information. At the end of the conference, a **Scientific Advisory Committee** was formed from among the delegates to provide ongoing direction for the report and to monitor its progress. SARDC staff prepared chapters with the collaboration and support of 24 **expert contributors**. At each draft stage, the Advisory Committee together with about 30 **specialists** reviewed and commented on the material. Thus, a knowledgeable team made up of staff writers, contributors, and reviewers were responsible for each chapter of the report.

With the production of a complete, but draft manuscript, the Advisory Committee convened a two-day workshop to review the whole report, and develop the final chapter on trends and future scenarios. This final chapter was conceived from the contributions of both regional experts and external representatives from other African nations, Europe and North America. The workshop delegates represented a wide array of disciplines and backgrounds.

**The Result**

The Southern African region and its member nations have, since the report's release in late 1994, a credible, scientific information foundation on which to base policy decision making and improve public awareness. The extensive collaboration process used means that the report has the acceptance and the authority required to guarantee its future utility. This participatory and inclusive process will continue to be used by the region's organizations as they proceed to develop further SOE products, including a thematic state of the environment assessment of water resources and issues.

**BOX 2-4 (Cont.)**

Source: Correspondence from Munyaradzi Chenje, Editor and Programme Coordinator, India Musokotwane Environment Resource Centre for Southern Africa; and Media Kit for State of the Environment in Southern Africa.

A tested approach for collaborative capacity building includes the following steps:

- evaluate the environmental assessment and reporting needs of the country and its institutions;
- develop integrated proposals to address the organizational structure, technology, and human resource needs;
- secure financing for implementing the capacity building program;
- monitoring and evaluating the implementation results, and adjusting as required.

This is essentially the regional approach being taken by UNEP's Environment and Natural Resource Information Networks Programme (ENRIN). In Central and Eastern Europe, for example, GRID-Arendal is coordinating environmental information capacity building through environment ministries of countries with economies in transition (See Figure 2-2). Similar efforts are underway in the Asia-Pacific Region. The discussion below summarises the overall approach for Central and Eastern Europe, while Box 2-7 illustrates a more specific capacity building project related to state of the environment reporting in Viet Nam.

In Central and Eastern Europe, the capacity building program follows four stages: initial assessment; feasibility and pilot; implementation; and operational (United Nations Environment Programme, 1994a). The initial assessment, conducted over a period ranging from one to 12 months, provides an overview of the current status of environmental information in the country, including existing system capacities, user needs, and problems associated with integration and harmonization (for example, see Denisov, 1995). This

**BOX 2-5**

**TERMS OF REFERENCE FOR A PUBLIC ADVISORY COMMITTEE**

**Rationale**

The establishment of a public advisory committee or council provides a way of incorporating strategic advice and direction to a SOER program from a partnership with interested representatives of external expert and community groups. Such a body, reflecting the views of various reporting constituencies, can guide the future direction of reporting, evaluate emerging environmental issues, review environmental reporting progress and products, and comment on research and data needs.

While it is not possible to have members from all interested parties on an Advisory Group, there is a need for good representation. The size of such a body should probably not exceed 15 members otherwise it would become too unwieldy. Within such dimensions, regional and national; sectoral (such as environment, natural resources, and health); societal (such as industry, academia, scientific community, consumer and environmental NGOs); and cultural groupings should ideally have a voice. To maximize representation, albeit indirectly, it is advisable to select prominent members from associations wherever possible. Often it is possible for one member to represent more than one perspective, for example a representative from industry can also reflect the viewpoint of a particular region of cultural group.

In Canada, a *Public Advisory Committee for State of the Environment Reporting* was first established in 1988 to advise the two departments, Environment Canada and Statistics Canada, responsible for coordinating the federal initiative. The Committee represents an integral element of the overall organizational structure for the program (see diagram below).

**Terms of Reference**

The SOE Public Advisory Committee functions are to:

- Advise on policies guiding the planning and development of the State of the Reporting program;
- Assist in the identification of environmental information and data needs in Canada;
- Provide an evaluation role to ensure relevance and effectiveness of the State of the Reporting activity.

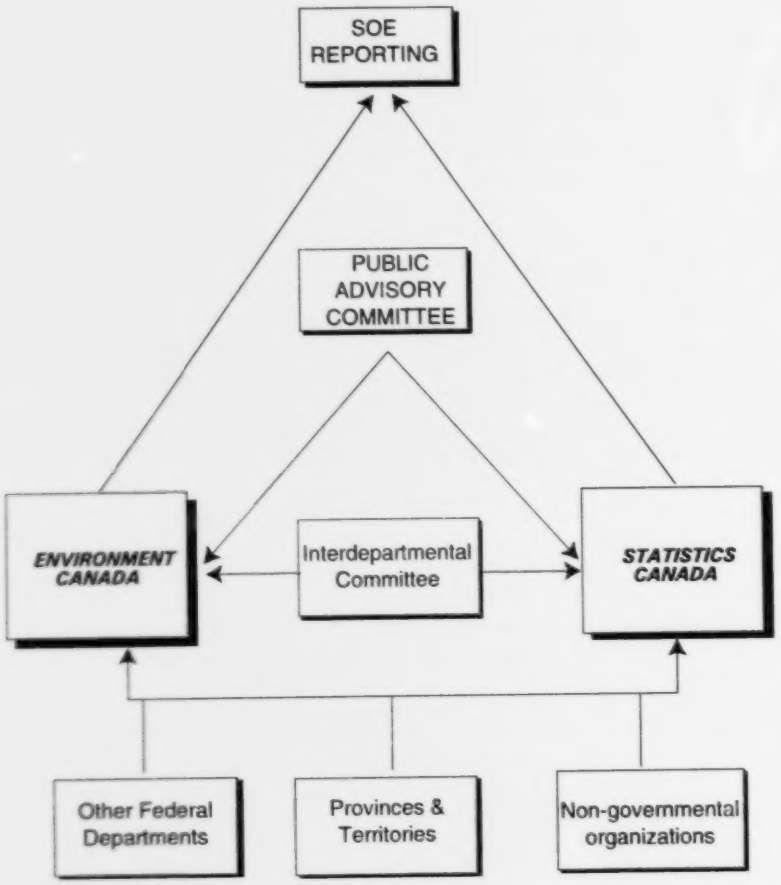
The Committee's advice is independent and in the public domain.

**Membership and Procedures**

- Selection of Committee members will be based on their expertise in environmental matters and on the need for geographic representation.
- The Committee will include a maximum of 10 members selected from the following groups: environmental organizations; labour; academia; industry; consumer groups. It will elect its own Chairperson.
- Committee membership will normally be for 3 years, with approximately a third of the membership renewed in any one year to maintain continuity.
- The Committee will meet at least twice a year and will submit an annual report.
- Environment Canada and Statistics Canada will share the secretariat functions and expenses associated with the functioning of the Committee.

**BOX 2-5 (Cont.)**

**CANADIAN FRAMEWORK FOR STATE OF THE ENVIRONMENT REPORTING**




Source: Environment Canada, 1994a.

status report provides a focus for national project initiation workshops with participants representing national environmental and sector institutions, international agencies, and interested donors.

The advice and direction of the workshop delegates is used to initiate the second feasibility stage. This stage provides a thorough assessment of environmental information systems (EIS), and recommends actions to strengthen capacities and access to environmental information, including the development of an institutional network. Two reports are produced from this phase: a) a feasibility study on the EIS status, outlining the needs, capacities and proposed actions; and b) an implementation proposal for a three to five year implementation stage leading to an environmental information network in the country compatible to UNEP-GRID.

**BOX 2-6**

**NON-GOVERNMENT PARTNERSHIPS FOR SOER**

**Background**

State of the Environment Reporting is generally considered the domain of governments and the international institutions they establish. However, the non-government sector, whether it be private business, universities, or non-governmental organizations can make valuable and unique contributions to the field, including the preparation of SOE products. In addition, the non-government sector can contribute through partnerships with organizations responsible for SOER programs. This approach has been used to good effect by the European Environmental Agency (EEA).

The EEA has recently published a comprehensive Pan-European SOE report entitled, *Europe's Environment: The Dobris Assessment*. The report was requested by the Pan-European Conference of Environment Ministers in June 1991. The overall task itself was completed through the cooperation of the European Commission, the UN Economic Commission for Europe (UNECE), UNEP, OECD, the Council of Europe, IUCN, the World Health Organization (WHO), Eurostat, and member countries. A project Group and National Focal Points were used to organize and plan the project, keep countries informed of progress, and review and correct drafts. However, the project provides an example of another form of partnership with the private sector which reveals an innovative way for an SOER organization to do business.

**Product Development**

It is normal for the private sector to be involved in the production and dissemination of SOE products. This can be in the form of product preparation and printing, editing contracts, or product dissemination. The EEA has gone further by inviting the private sector to develop spin-off products from the contents of its comprehensive report.

From the start, it was recognised that a single report would not be able to serve all uses and users. A diverse family of products built from the Dobris Assessment would be required to meet the needs of a variety of audiences. Beyond some internal companion products, such as a statistical compendium, the Agency invited publishing houses and consortia with a record in the environmental field to submit proposals and offers for the development, publication, and dissemination of a series of other complementary products. In the Call-for-Tender, the following proposals to be developed in partnership with the Agency in 1995 were requested:

- **other language versions** of the report to be completed in collaboration with the appropriate national focal points;
- a **popular version** of about 200 pages for the general public;
- a print and interactive electronic **environmental atlas** of approximately 100 maps;
- a small format **pocket book** of statistics for quick and easy reference;
- **educational material** for different age groups;
- **other suggestions.**

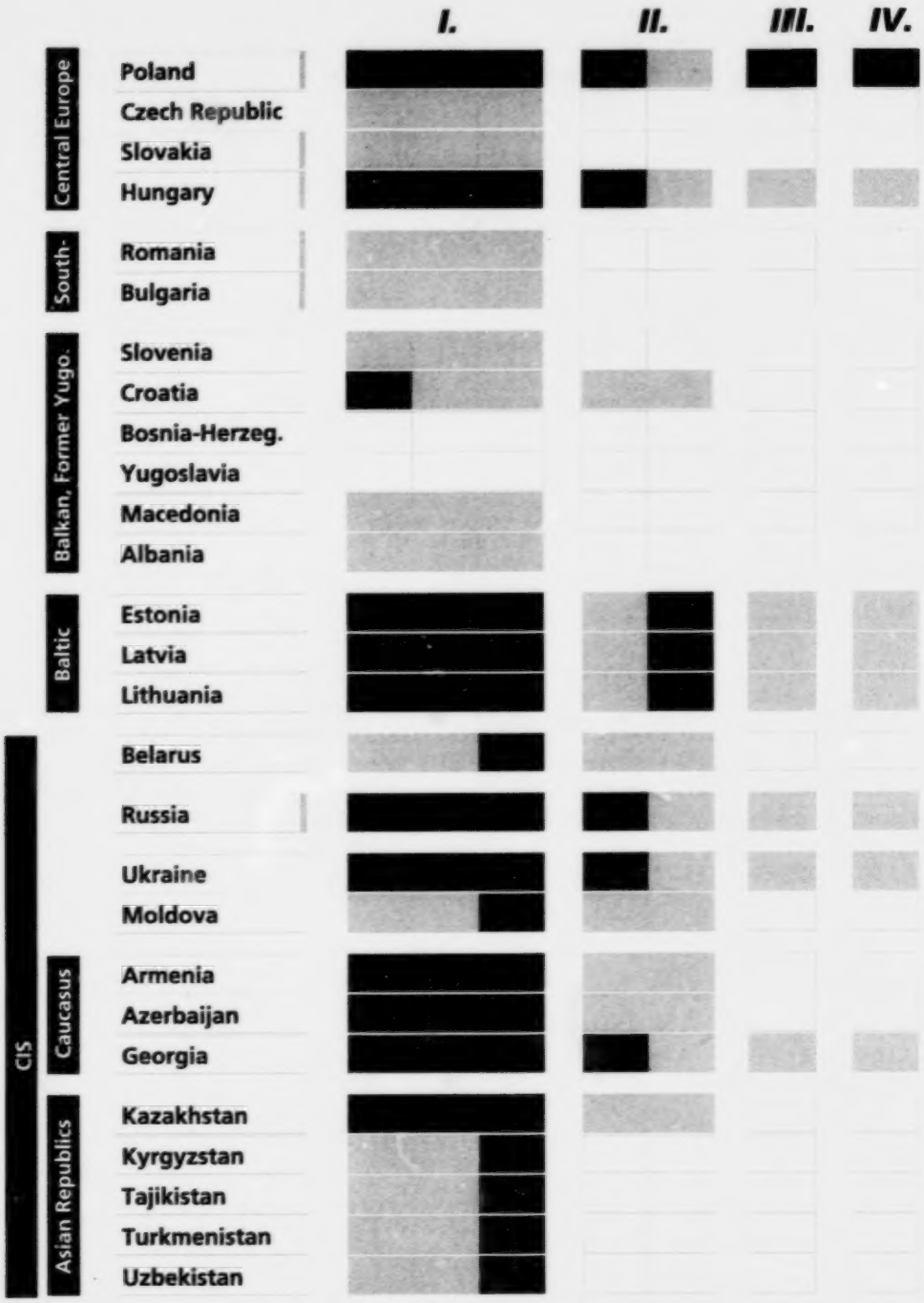
Source: Stanners and Bourdeau, 1995; and European Community, 1994.

In the proposal for Hungary, a three-year implementation phase is directed at achieving a national environmental information network compatible with international systems. At the end of three years in 1998, Hungary is expected to have trained personnel, state-of-the-art equipment, and a sound legal, institutional and economic base for the generation and dissemination of environmental information relevant to decision makers and the general public (United Nations Environment Programme, undated a). The results will include:

- a fully operational core unit based on modern GIS and telecommunications technology;
- easily interpretable, visual environmental information products such as a national SOE report;
- an aggregated national spatial environmental database accessible to users in Hungary and internationally;
- a meta-database of national environmental databases and institutions;
- reports and data products of inter-sectoral, cooperative projects;
- methodology and standards publications on data and information systems;
- international access to Hungarian environmental data and information to contribute, for example, to a 2002 global SOE assessment.

The GRID-Warsaw facility, established in Poland in 1991, represents an operational example of the results of the ENRIN initiative in eastern Europe (United Nations Environment Programme, 1994c). The outputs of this centre mirror those outlined above, and include the production of the recent SOE report for Poland (Andrzejewski and Baranowski, 1993). This report, produced through a collaborative effort, is based on the compilation and integration of a large amount of data and their cartographic portrayal using GIS technology.

**Figure 2-2**
**Environmental Information Capacity Building in Central and Eastern Europe**




Source: UNEP, 1994a

**BOX 2-7**

**CAPACITY BUILDING FOR STATE OF THE ENVIRONMENT REPORTING IN VIET NAM**

**Background**

In 1994, UNEP commissioned a consultant, ESSA Technologies Ltd., to work with the Government of Viet Nam to provide technical assistance on state of the environment reporting. The project objective was to increase the capacity of Viet Nam's National Environmental Agency (NEA) to prepare SOE reports. The terms of reference for the project required the consultant to work closely with a Vietnamese government SOE Working Group to:

- consult and revise environmental program proposal documents being prepared for consideration by the Viet Nam National Assembly;
- hold training workshops for all members of the Working Group on the format, methodology, content, and data and monitoring requirements for SOE reports; and
- make recommendations on the necessary monitoring and data gathering systems needed to improve future reporting in Viet Nam.

**Results**

The consultant:

- provided recommendations to strengthen the National Assembly report after conducting a chapter by chapter review and holding two group sessions to allow a wide range of agencies to provide NEA with constructive criticism;
- conducted a three-day workshop on internationally accepted SOE principles and practices for about 30 experts including the members of the SOE Working Group;
- provided a reference library of SOE documents and reports;
- developed recommendations and a proposal to establish a long term SOER program in Viet Nam, including administrative arrangements, the use of indicators and targets, the improvement of monitoring and data collection, and the adoption of spatial frameworks.

This capacity building support has contributed to the production of a coastal and marine SOE report for Viet Nam, and enabled the country to more effectively contribute to regional reporting and assessment initiatives.

Source: ESSA Technologies, 1994.

# III CONCEPTUAL APPROACHES

## 1 Introduction

For transparent SOE reporting, we need to be aware of the conceptual basis for our analysis and interpretation. The goal is credible information, but this does not mean that information is completely neutral and value-free. The information that we generate will be influenced by the way we see the world. If environmental issues, for example, are used to structure reporting, their selection represents a value judgement. This chapter therefore examines the conceptual underpinnings that frame state of the environment reporting. This sets the stage and context for later chapters on data management, indicator development, forecasting, and reporting products.

Various authors have noted the current lack of generally accepted theory behind SOER (Campbell and Maclaren et al, 1995). Nevertheless, practice in the field would indicate that the context for SOER is changing from describing the condition of biophysical components of the environment, to a wider scope incorporating a systems approach which recognizes the linkages between the environment and the socioeconomic domains. Concepts such as *environmental sustainability* and *ecological footprint*[1] are emerging in SOER. In addition, we are beginning to grapple with reporting on the broader and complex human development-environment themes such as poverty, trade, and consumption.

In essence, the state of the art has moved from sectoral reporting to providing the environmental component of sustainable development reporting (See Figure 3-1). SOER conceptually encompasses the state of the environment and factors that affect (human activities and natural events), or are affected (human health, economic and social conditions) by the state of the environment.

Despite the absence of general theory, there are several conceptual models that have a complementary relevance to SOER. These would include Natural Resource Accounting and environmental auditing. These are brought to the reader's attention, but will not be discussed in any detail below. This chapter will focus on the conceptual thinking, approaches, and frameworks of direct application to SOER.

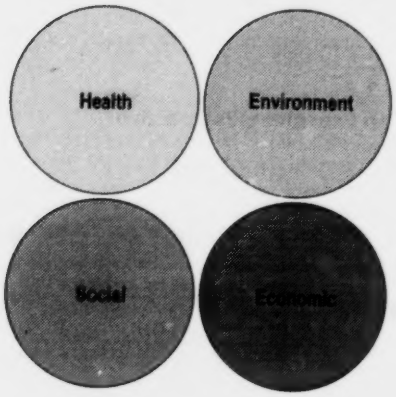
Ideally, a conceptual framework for SOER should facilitate the adoption of a systems approach to providing information for decision making. The framework should provide a way to organize, analyze, and present environment-related information to improve its accessibility and usefulness. Nevertheless, the conceptual thinking should reflect the limits to our understanding of ecosystems, their functions and interactions. The conceptual frame should, as much as possible, be responsive and anticipatory to provide the link between society's evolving objectives and priorities for the environment and development; research needs; and monitoring and data collection efforts.

## 2 The Ecosphere and Conceptual Paradigms

Before space technology, we could only regard our world from within and our conceptual approach consisted largely of studying the environment piece by piece. Now with the benefit of satellite images, we can see the total unity of the Ecosphere. Such images bring

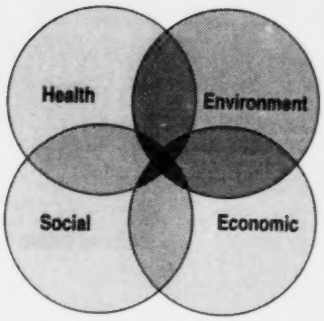
[1] Appropriated carrying capacity (see Wackernagel et al, 1993).

**Figure 3-1**
**Broad Conceptual Models for Reporting**



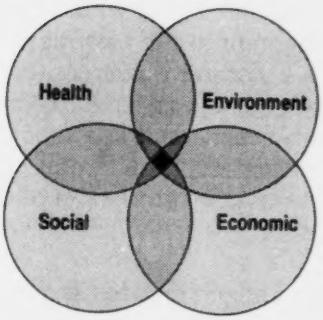

**A. SECTORAL REPORTING**

Separate; no integration




**B. STATE OF THE ENVIRONMENT REPORTING**

Integration with environment as the focus; the environment ingredient of SD reporting




**C. SUSTAINABLE DEVELOPMENT REPORTING**

Full integration; hypothetical & complex

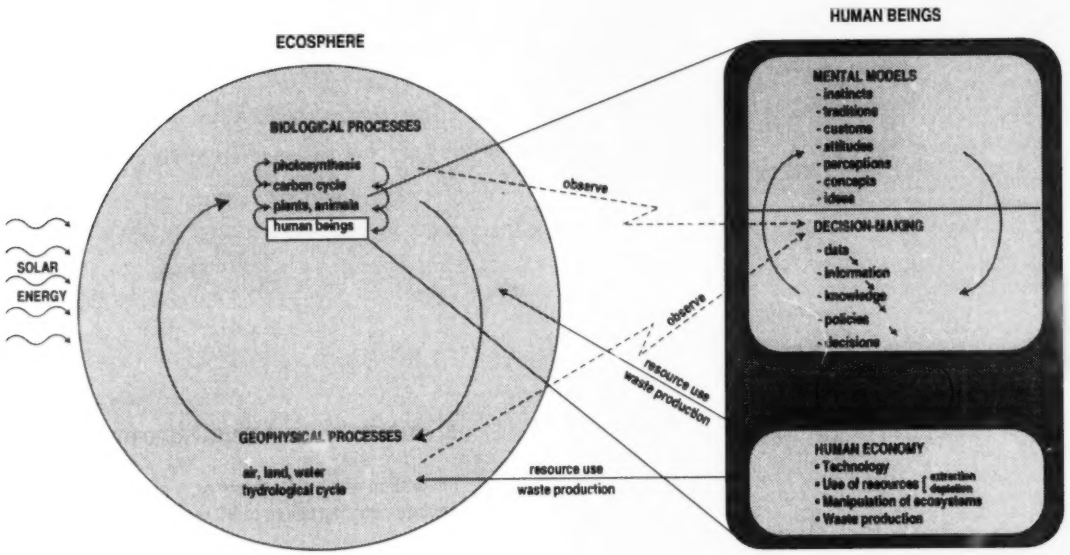
Adapted from Campbell & Maclaren, 1995

reality to the need for sustainable development and the adoption of holistic, ecosystems approaches.

If we look at the Ecosphere from a sustainable development perspective, it is possible to see three significant factors at play (See Figure 3-2). There are *natural phenomena*, such as storms, floods, volcanoes and earthquakes. Until recent times, these events were the main agents of environmental change, and still cause frequent catastrophes. Second, is the combination of *human population and technology*, which today can have a deep, pervasive impact on environment and natural resources as a result of energy consumption,

shelter and food requirements, lifestyle, trade, and manufacturing. Third is our *perception* or *mental thinking* about how the world functions. This thinking has its roots in our culture, values and beliefs, and helps to explain our decision making and rationale for collecting and using information.

**Figure 3-2**
**Conceptual Elements from an Ecosphere Perspective**




Source: State of the Environment Reporting, Environment Canada

Various authors have suggested some fundamental paradigms which have governed our environmental management and economic development in the twentieth century (Colby, 1990; and Mathews and Tunstall, 1991). Where natural resources are abundant and human capital is scarce, the paradigm of *frontier economics* tends to prevail. Here the environment is regarded solely as a source for new supplies and a repository for waste. Increase in production could be gained from expansion into new areas. Decision making is based on socioeconomic factors with the goal to increase throughput of raw material and energy.

With an increase in concern over pollution, the paradigm centred around *environmental protection* emerges. Here, economic considerations still predominate, but correcting the most obvious forms of pollution through mitigation and regulatory means are added as externalities to set limits to the more obvious sources of pollution. However, as the economy evolves pollution continues to increase and becomes more costly to abate.

As a result of growing environmental awareness, *resource management* represents a third paradigm. From an operational viewpoint, it represents the predominant way of thinking about environment and development today. Under resource management, all types of resources--biophysical, human, structural, and fiscal--are considered in development policies aimed at maximizing societal welfare. Natural resource depletion, the interdependence and multiple value of resources, and the "polluter pay" principle become important factors in policy decision making.

The most balanced approach, and the one which society now embraces, at least in principle, is represented by *sustainable development,* whereby human development is maximized without compromising the environment into the indefinite future. Because of the extreme broadness of the concept, it is possible to consider sustainable development from a number of perspectives such as environmental sustainability; economic sustainability; cultural sustainability; political sustainability; institutional sustainability, and social sustainability (see Yap Environmental Systems Analysts Ltd., 1994). Obviously, it is extremely difficult in an operational sense to strike the appropriate balance and maximize the achievement of five or six goals simultaneously and continually.

In this report, the focus is on reporting environmental sustainability, together with the linkages to the other goals. Thus, the starting point is represented by the three essential functions of the environment: as a life support system; as a sink and assimilator of waste; and as a source of energy and raw materials. From these functions, three societal goals related to environmental sustainability can be stated: assuring ecosystem integrity; assuring human health and well-being; and assuring natural resource sustainability. This way of "global" thinking maintains, that within an ecosystems perspective, a healthy environment and a prosperous economy are interdependent. Sound decision making is anticipatory and dependent on the integration of environmental and socioeconomic considerations. Sustainability requires emphasis on systems efficiency and the elimination of waste through prevention, reduction, recovery, and recycling.

Grappling with environmental sustainability requires an approach focusing on ecosystems as dynamic, interacting, living systems. Human beings must be considered part of ecosystems. The challenge of ecosystems thinking is to recognize and understand that everything is connected to everything else in a complex web. Maintaining the integrity and health of ecosystems in perpetuity is part of this approach. We have to strive to maintain natural capital of the environment, living off the interest while building human capital. Ecosystems exist at different scales--from the ecosphere, to landscapes, to elements such as ponds. Thus, an ecosystem spatial framework is a key tool to understand ecosystems and interpret environmental sustainability.

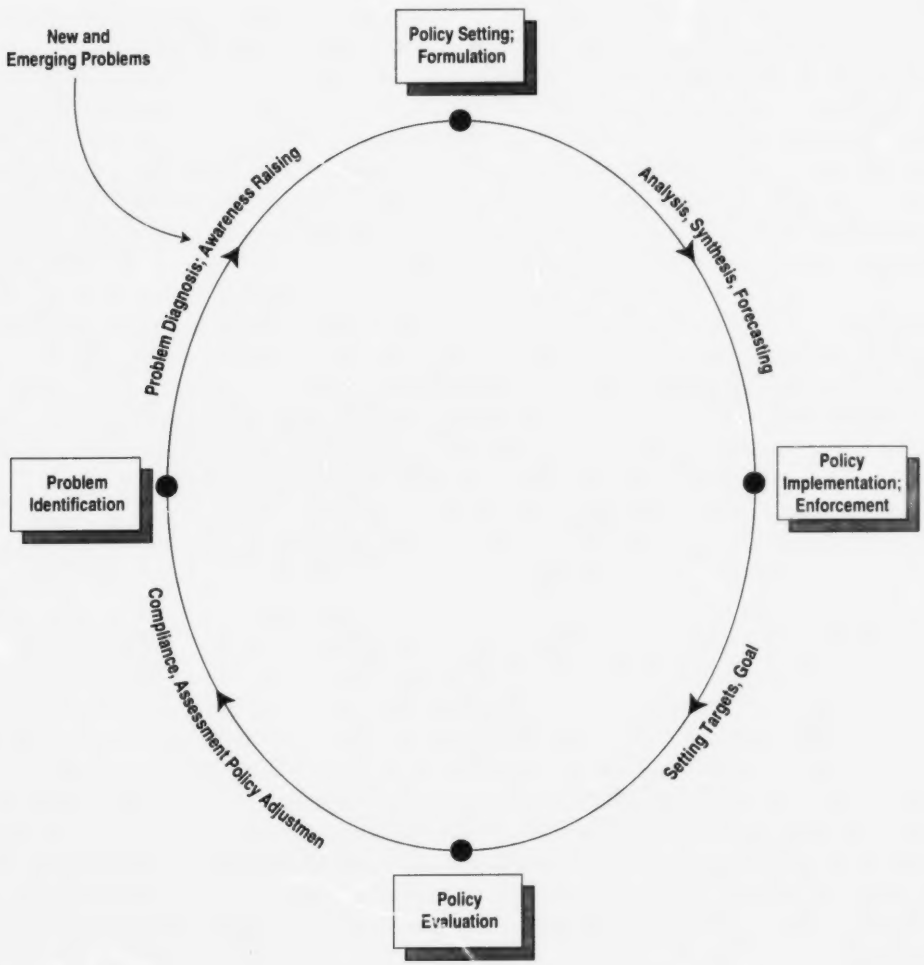
How does this shift in approach affect information requirements? With the environment regarded as a "free" resource, the key information relates to production, with productivity measured in terms of output per unit of land, capital, and labour. With the focus on pollution and human health, countries develop programs to monitor emissions and ambient conditions of air, water, and land. Under the resource management approach, the information horizons are expanded to encompass a full accounting of renewable and non-renewable stocks and flows, and the measurement of resource value. Finally, the information requirements under a sustainable development regime will need to be expanded even further to include better information on the functioning and carrying capacity of ecosystems, with a full accounting of materials used and wastes produced by communities.

This review of the evolution of environmental management paradigms helps to explain the relative imbalances across the information spectrum. Data and information on human activities and emissions are required under frontier economics and environmental protection regimes respectively. That such data are relatively well developed reflects the longer history and experience behind these paradigms. We are still in the process of developing and integrating our information sources on the systems basis needed for resources management and the measurement of sustainability.

## 3 Information and Policy Decision Making

If SOER information is to be used in a policy context, it is useful to examine the decision making process (Holtz, 1991). Decision making is continuous and dynamic, but for illustrative purposes can be categorized into four stages: problem identification, policy formulation, policy implementation, and policy evaluation (See Figure 3-3). SOER can facilitate effective decision making at all four stages by providing synoptic information to raise awareness, allow the evaluation of alternative policy options, and assist with policy performance measurement.

**Figure 3-3**
**The Decision Making Cycle**




Source: RIVM

The catalyst for the first stage of the policy cycle is the identification of priority environmental problems requiring societal action. The initial diagnosis of such problems usually originates from non-government organizations (NGO) or the scientific community. SOER can help build awareness of priority environmental issues in a sustainable development context. This role can be particularly useful for emerging issues which are not yet on the political agenda. By disseminating credible information which defines the socioeconomic and environmental dimensions of issues, SOER can help the public and decision makers decide whether policy actions are warranted or not.

The second stage of the decision making cycle represents the formulation of policies and strategies to address the selected priority issues. Environmental problems are increasing in complexity making the analysis of policy options a critical and sensitive task particularly in a sustainable development context. SOER information, relating agents of change to environmental conditions and ecological carrying capacity, would be useful in the formulation of scenarios and forecasts concerning the potential consequences of various policy alternatives.

In the third stage of the decision making process, selected policies emerging from the previous stage are put into effect. Goals and targets are established by society to guide the implementation and enforcement of the range of measures associated with the chosen policy direction. The mix of policies chosen should reflect the need for correcting existing problems, and preventing new ones. Information on the state of the environment will help set the appropriate goals and targets to achieve progress towards sustainable development.

The final stage of the decision making cycle evaluates the effectiveness and impact of the adopted policies. Here, SOER can provide the factual assessment of the performance of implemented measures against environmental goals and targets. Such an assessment, together with cost effectiveness and the degree of social acceptance, can be fed back into the policy cycle to fine-tune and improve the societal response.

This conceptual and simplified view of the decision making process helps to demonstrate the potential application of SOE information to policy formation and evaluation. From this perspective, SOER should not be considered an end in itself, but rather a means to incorporate environmental considerations in decision making to achieve sustainable development.

## 4 Organizational and Spatial Reporting Frameworks

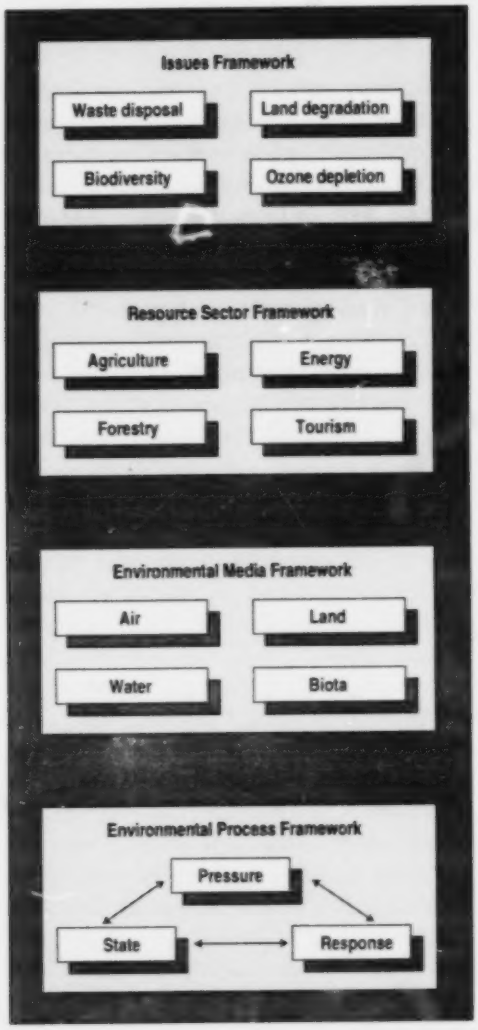
Every author or institution that has published an SOE product has applied, consciously or otherwise, a conceptual framework to structure the reporting (Hamilton, 1991). As noted above, a framework is needed to structure the presentation and analysis of SOE information. Yet, as one author concludes, SOE reports are characterized by excessive data and a lack of focus (Yap Environmental Systems Analysts Ltd., 1994). The range of potential data and the complexity of environment-socioeconomic relationships are extremely wide and diverse. A more conscientious adoption of a framework would help to bring order and convergence to the structure and contents of SOER products.

Several alternative frameworks are available and have been used to organize the presentation of complex information on conditions and trends in the environment. Essentially, the choice of a reporting framework is determined by the study objectives, the type of institution, the need to effectively satisfy user requirements, and the constraints imposed by available data. The selection of a particular framework will influence the relevance and ease of understanding for the user, the extent to which ecosystems dynamics and socioeconomic-environmental integration can be accomplished, and the scope and format of the reporting product.

Sheehy (1989) has provided a useful analysis and classification of the various organizational frameworks available for environmental reporting. SOER products can be organized to highlight priority issues such as land degradation or climate change (See Figure 3-4). They can assess the conditions and trends of environmental media such as air, water, land, and flora and fauna; or economic sector such as agriculture or forestry.

Another approach is to emphasize environmental and socioeconomic processes, interpreting and assessing their relationships within ecological systems.

**Figure 3-4**
**SOER Organizational Frameworks**




Adapted from Campbell & MacLaren, 1995

From a spatial perspective, the analysis of environmental conditions and trends can be presented by political-administrative boundaries, various types of environmental units such as watersheds, or ecosystem boundaries. In the selection of a spatial frame for reporting, a choice must be made between accepting and using the available, but often incompatible boundaries used by the data gathering agency; or creating an integrated database using the capabilities of a GIS to create a common spatial frame for all themes.

In practice, most products use more than one organizational approach in an attempt to meet the diversity of audience needs. The use of multiple approaches can be justified as complementary recognizing the complex nature of environment-development interactions. However, such comprehensiveness can result in a large and complex product which may be overwhelming to the user unless, for example, electronic search capability is employed (Comolet, 1993).

Organizational Frameworks

- *Issues:* Many products focus on significant contemporary or emerging issues which have longer term consequences. Such an approach has remained popular since the early period of SOE reporting. However, the array of issues is beginning to shift from the traditional environmental issues such as acid rain and soil loss to include broader sustainable development issues such as poverty, and consumption and lifestyles. This approach has the advantage of political relevance and timeliness. A focus on issues can increase public awareness of emerging and priority issues. In practice, it tends to represent a "react and cure" approach which emphasizes certain issues at the expense of a more systematic and comprehensive analysis. However, a ranking can be employed to select priority issues for SOER. Bollen et al suggest a ranking scheme based on reversibility, spatial scale, risk magnitude, scientific uncertainty, and public awareness (Table 3-1).

**TABLE 3-1**

**CRITERIA FOR ENVIRONMENTAL ISSUE RANKING[1]**

| Criteria | Possible Weighting | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Reversibility | Less than 1 year | Less than 25 years | More than 25 years |
| Spatial Scale | Global | Transboundary | National |
| Risk Magnitude | Moderate | Significant | Serious |
| Scientific Uncertainty | Low | Moderate | High |
| Public Concern | Low | Moderate | High |

Adapted from: Bollen et al, 1994.

- *Economic Sector*: This approach uses a human activity classification as the basis of organization. Typical reporting categories could include agriculture, forestry, fisheries, mining, tourism, industry, transportation, and energy. The approach takes advantage of the way national governments and statistical systems tend to be organized. Such a framework provides information on the benefits and products derived from the environment and the economic consequences of environmental trends. However, the sectoral reference is rather narrow in focus and may neglect broader ecosystems linkages and implications.

- *Environmental Media:* The media approach represents the traditional way of reporting on the state of the environment reflecting both the way we commonly divide the environment into components and the way environmental monitoring is structured. The use of environmental media often reflects legislative mandates and national goals. Although a media approach facilitates comprehensive analysis within each environmental component, it is weak at accommodating ecological processes or pervasive problems affecting more than one environmental medium.

[1] Based on reporting at the national level with equal weighting for each criteria.

- *Environmental Process*: This approach is based on the assessment of the impact of human activities on the physical and biological processes of ecosystems, such as the circulation and bio-accumulation of contaminants, alteration in community structure, and decrease in system stability. The concentration on dynamic relationships reflecting both cause and effects provides systematic and comprehensive coverage in a cross-sectoral and integrative manner. Such a framework facilitates the development and evaluation of policy responses to environmental problems.

The advantages of such an environmental process approach to SOER has resulted in the widespread adoption of the **pressure-state-response** model (See Figure 5-3). According to this framework, human beings exert pressure on the environment, such pressures induce changes to the state or condition of the environment, to which society responds with policies and programs to prevent, mitigate or repair environmental damage. There are several elaborations on the basic pressure-state-response model. In some discussions, a distinction is made between driving or underlying forces, such as population growth and technology development, and the more specific human activities on the pressure side; while others split the state part into functional changes called impacts from changes in the characteristics of the environment (Schulze, 1994; Swart et al, 1994). With climate change, for example, ambient levels of greenhouse gases would be recognized as state measures, while sea level rise would be regarded as an impact.

In many respects, such a process framework encompasses the elements of the other less-comprehensive organizational approaches outlined above. Issues can be used to categorize the origin of pressure, while the environmental media categories are often used to subdivide the environmental state. The model can use economic sectors to both classify human induced pressures and societal responses.

Spatial Frameworks

- *Jurisdictional Units*: This spatial framework referenced to political or administrative boundaries is commonly applied in SOER. At the supra-national level, countries are frequently used, while within a national context state, province, local government, or management units may be used. This familiar framework reflects the way society is organized for political and administrative purposes. However, such boundaries are usually not ideal for the analysis and interpretation of data on environmental conditions and trends.

- *Environmental Component*: The use of environmental components as a spatial reference for SOER represents a compromise between the organization of available data and the need to interpret a complex environment. Environmental factors such as soil type, vegetation, topography, climate, life zones, or drainage basin can be used to determine reporting units. Various environmental regional units, such as watersheds, are used as surrogates for more integrative ecological regions. Such surrogates stress one component, however, at the expense of a holistic perspective. The boundaries for each environmental component will be different, and if several are used for reporting it is difficult to cross-reference data to other subject areas.

- *Ecosystem Spatial Framework:* Such frameworks use geographic units which contain distinctive sets of abiotic and biotic features that are ecologically interrelated. A hierarchical, nested approach can be used to ensure that an appropriate spatial resolution is available at different scales (See Box 3-1). With an ecosystem framework in place, a common spatial reference is available for the various data generators to integrate information within standardized geographical

boundaries defined by ecological parameters. Such an approach is particularly appropriate for the interpretation and assessment of environmental data and ecological linkages.

**BOX 3-1**

**THE CHARACTERISTICS OF ECOSYSTEM SPATIAL FRAMEWORKS**

**Context**

The need for broad ecological regionalization of regions and countries has been recognized for a long time (Beale, 1980; and Omernik, 1995). Such a spatial framework is recognized as an aid to ecosystems thinking about monitoring, reporting, management, and policy development. Although progress has been made in the delineation of ecological regions on national and regional scales, the basis and classifications used varies, with the selection often determined by a specific purpose. This can lead to the development of many regionalizations, each with a unique set of boundaries. Thus, comparison and comprehensiveness is compromised. More recently, the development and application of more generic ecological regionalizations based on a multitude of factors is being undertaken to meet a diversity of user needs. In this evolution, three stages moving from ecosystems defined by environmentalcomponents to those defined by a combination of factors can be recognized:

- one environmental component is used at a single level;
- different environmental components are used at each level of a hierarchical system;
- a multiple combination of factors is used to define common boundaries according to their relative importance for any particular area or hierarchical level.

Despite the acceptance of a holistic ecosystems approach for reporting, this is not often demonstrated by the use of ecosystem spatial frameworks. The aim here is to encourage the more widespread application of such frameworks in SOER by examining their development in three contrasting situations--an island nation in the Pacific, the Netherlands, and the North American continent.

**Terrestrial Ecosystem Mapping in Western Samoa**

In 1991, a project to define and map the principle terrestrial ecosystems of Western Samoa was completed. This four-year project was commissioned by the national government to support a systematic approach to conservation and land planning, in particular the development of an updated protected areas network. Using the knowledge gained from the project, a conservation priority was assigned to each ecosystem based on rarity, distribution, and threat, both from global and local perspectives.

The researchers used existing information, remote sensing (aerial photography and SPOT images), and field verification to inventory and classify the terrestrial environment. A nested, hierarchical system was used to map the ecosystems which were primarily delineated using vegetation. Degree of disturbance, land forms and soils were additional factors considered in the interpretation.

Subsequent to the initial project, the ecological information has been digitized and incorporated into an ARC/INFO GIS under the auspices of the South Pacific Regional Environment Program. The GIS contains considerable additional information on, for example, soils, land use, land tenure, and land capability. Thus, the building blocks are in place to enable the consideration of the multitude of biophysical factors which shape ecozones. Such a database, although not originally designed for SOER, has considerable potential for the analysis and interpretation of the state and changing conditions of the environment.

**BOX 3-1 (Cont.)**

**Ecosystem Classification in the Netherlands**

In the Netherlands, an ecosystem classification has been used to divide the country into ecoregions, ecodistricts, and more specific spatial units (Klijn, 1994). The recommended approach distinguishes between ecosystem classification and mapping; in other words between definition and recognition. The classification is based on the factors that cause the ecosystem pattern, while for mapping, all characteristics that help show the pattern are used.

Using this approach, the country has been divided into six ecoregions based primarily on geological and geomorphological characteristics, with groundwater and altitude used as additional determining factors. These regions are, in turn, divided into 37 ecodistricts: 26 terrestrial and 11 aquatic types. Typical examples of Dutch ecodistricts include polders, drained lakes, and lowland peat. These units are defined using a combination of geology, geomorphology, groundwater, and surface water; and largely correspond with soil groups as determined by parent material.

The ecosystem spatial framework has been used for various environmental management applications including assessment of ecoregion susceptibility to environmental problems such as acidification, eutrophication, and desiccation; and predictive modelling on the effects of changes in water management. The former application is used in the Dutch state of the environment reports to provide an integrated picture of the quality of the environment (Langeweg, 1989).

**Ecological Regionalization in North America**

In 1993, professionals from government, non-government groups, and academia in Mexico, Canada, and the United States discussed the application of an ecosystems approach to North American reporting. Recommendations were made on the development of an integrated database to cover the pressure-state-response continuum at local, national, and continental scales. The development of a consistent ecosystem map for North America was recognised as a key framework for such a database. As a result, a tripartite working group is working towards the development of a compatible ecological regionalization to serve a variety of assessment needs related to sustainability. Its first application will be to analyze protected areas in terms of ecosystem representation and integrity.

The basis for such a harmonized spatial framework is available from the existing ecological maps and classifications already developed in each country. Although the typology may differ, all three countries use a hierarchical, nested approach. The working group has accepted three levels of generalization to meet national, continental, and global needs. More detailed units within this structure could serve local requirements, but would be the responsibility of the individual country. Draft maps have been prepared for Level I (the coarsest level) and Level II of the regionalization. The approach used to determine unit boundaries and descriptions depends on the analysis of the patterns and composition of biotic and abiotic characteristics that affect or reflect differences in ecosystems. Thus, a combination of factors such as climate, physiography, hydrology, soils, vegetation, fauna, and human use will be used to derive the harmonized ecological regions. The relative influence of each characteristic on the ecological regionalization will vary according to the area, and is independent of hierarchical level.

Principal Sources: Pearsall and Whistler, 1991; Gauthier and Wiken, 1995; Klijn, 1994; and Omernik, 1995.

Assessment of Frameworks

Table 3-2 summarizes the advantages and disadvantages of the various organizational and spatial frameworks available. The desirability of an integrative, holistic structure which focuses on cause-and-effect linkages between the environment and socioeconomic systems must be recognized and pursued for SOER to serve the sustainable development paradigm. For these reasons, the pressure-state-response model based on an ecosystem spatial framework represents the best existing conceptual approach on which to structure SOER. If current circumstances constrain the complete adoption of such an approach in the short term, progress towards its adoption should be pursued over the longer term to meet the fundamental objectives of SOER.

Nevertheless, certain reservations and cautions must apply. Care is necessary, for example, in the interpretation and application of the pressure-state-response model. Its connection to cause-effect associations make it attractive from a decision making perspective. However, the complexity of environmental problems and incomplete knowledge make it impossible to isolate specific pressures with specific impacts on a one-to-one cause-effect basis. Despite this limitation, the pressure-state-response model does provide a logical way of organizing and classifying environmental information for reporting purposes. This is demonstrated, for example, by the various environmental indicator initiatives discussed in Chapter V.

An ecosystems framework complements the pressure-state-response model for reporting by providing a spatial reference linked to conditions and relationships in the environment. This advantage facilitates greater understanding of environment-socioeconomic interactions, provides a tool for data harmonization between disciplines, and provides a neutral playing field for the various interests involved in decision making. However, while there is general agreement that ecoregions exist in a nested way, there is considerable debate on how to define them (Omernik, 1995). Many classification schemes have focused on particular environmental components at each hierarchical level assuming these to be the predominant determinants of ecoregions. Omernik contends that this approach can be effective in some areas, but not in others. In terms of application, the use of particular environmental components is well suited to specialized, single purpose use. To overcome this limitation, a true ecosystem spatial classification would recognize the combination and relative importance of all factors that explain ecosystem regionalization. This blend of characteristics would vary from place to place and from one hierarchical level to another (Omernik, 1995; Wiken, 1986).

Ecosystems frameworks, or their environmental component surrogates, have been mapped for many regions or countries (see Marshall and Scott Smith, 1995; Winograd, 1995; and Secretaría de Desarrollo Social and Instituto Nacional de Ecología, 1995). However, few attempts have been made to use such spatial frameworks for reporting itself; and it is exceptional to find a report structure which is dependant on such a framework. Even if the spatial framework exists, existing monitoring systems and data are generally not organized by ecosystem classification, and current SOE products are frequently limited to reporting on special or selected ecosystems, such as urban-rural regions, delta areas or lake complexes.

The usefulness of an ecosystems spatial framework for reporting is clear. However, it must be recognized that the state of the art is in the early stages of development. The development

and application of such frameworks for reporting should be encouraged, but its achievement for most programs must remain a long term goal.

TABLE 3-2

ADVANTAGES AND DISADVANTAGES OF ORGANIZATIONAL AND SPATIAL FRAMEWORKS

| Organizational Framework | Advantages | Disadvantages |
|---|---|---|
| **Issues** | • Attractive for decision making purposes<br>• Raises awareness of emerging issues<br>• Suitable when information availability is difficult | • Not comprehensive<br>• Does not emphasize linkages between issues or ecosystem components |
| **Economic Sector** | • Emphasizes human use of natural resources<br>• Data usually readily available | • Does not recognize ecosystem complexity or processes |
| **Environmental Media** | • Identifies trends in environmental quality<br>• Data usually available | • Does not analyze effects or linkages in ecosystems |
| **Environmental Process** | • Examines dynamic ecosystem relationships<br>• Illustrates cause-effect associations<br>• Facilitates development of societal response to environmental problems | • More complex to use because of incomplete understanding of ecological processes<br>• Suitable data may not be readily available |
| **Spatial Framework** | **Advantages** | **Disadvantages** |
| **Jurisdictional** | • Users relate to these familiar boundaries<br>• Most common unit for data collection, especially socioeconomic | • Ignores natural boundaries<br>• Fails to highlight ecosystem linkages |
| **Environmental Component** | • Logical approach to present data from an environmental perspective<br>• Takes advantage of data from natural resource agencies | • Difficult to make comparisons between various environmental components<br>• Can lead to a plethora of unit boundaries |
| **Ecosystem** | • Integrates environmental and socioeconomic data<br>• Reveals ecosystem linkages<br>• Consistent method of environmental reporting based on common units | • Ecosystems not always defined<br>• Data generally not well organized by ecosystem boundaries |

Adapted from: Campbell and Maclaren, Undated.

## 5 Conceptual, Organizational, and Spatial Framework Application

How have these various frameworks been used in SOER? Does the choice of framework vary depending on objectives, user needs, and data availability? The use of various frameworks in recent SOE reports is summarized below in a series of tables. Table 3-3

shows the use of environmental process and spatial frameworks. The selection of economic sectors, environmental media, and environmental issues is illustrated in Tables 3-4, 3-5, and 3-6 respectively. This does not represent an exhaustive review, but the tables do demonstrate the adoption of multiple or combined frameworks in comprehensive SOE reports.

A more select examination of a few recent, comprehensive state of environment reports both at the regional and national level will illustrate the conceptual thinking and organizational frameworks used to deliver environmental information. The SOE reports for Europe, Asia and the Pacific, and Canada have been selected for this purpose. All three examples adopt variations of the pressure-state-response, while the application of a spatial framework is more divergent.

In *Europe's Environment: The Dobris Assessment* a variation of the pressure-state-response model is adopted to present environmental complexities in as clear a presentation as possible (See Stanners and Bourdeau, 1995). The main body of the report is organized into four parts which present different views of the environment. Analysis of *environmental attributes* are presented for air, water, and soil media; and in more spatial or functional units as landscapes, ecosystems and wildlife, and urban areas. This initial part also includes a brief overview of human health in Europe.

In the report, *pressures* on the environment are discussed in two parts which focus on human activities and their outcome: the *sources of change*, and *agents of change*. The sources of change are divided into familiar economic sectors, for example agriculture, transport, and households; while the agents actually stressing the environment include emissions into air and water, waste, noise and radiation, chemicals, and natural and technological hazards. This separation into sources and agents is used to demonstrate that it is the extent and way human activities are pursued, rather than the activities themselves, that cause environmental change. In a fourth part of the report, special attention is given to 12 prominent *environmental problems* of particular concern for Europe. This section integrates information on environmental media, pressures, and human activities to provide a cause, effect, and response evaluation for each selected problem.

The conceptual and organizational structure of the report is shown in Figure 3-5. Such a model cannot hope to portray complex interactions in the environment, but it does illustrate a simplified progression from the sources of environmental pressures, to the pressures themselves, and finally to environmental conditions and problems as the effects. The figure clearly shows the boundaries between the SOE assessment of the report and the surrounding area of policy development and implementation. Thus, the report aims to provide a reliable and objective platform for decision making. By distinguishing between human activities, pressures, and environmental conditions, actions can be targeted at different points along the chain to, for example, address root causes or tackle the restoration of degraded areas.

**TABLE 3-3**
**THE APPLICATION OF ORGANIZATIONAL AND SPATIAL FRAMEWORKS[1]**

| Organization | Environmental Process[2] | | | Spatial Framework[3] | |
|---|---|---|---|---|---|
| | Pressure | State | Response | Jurisdictional | Environmental |
| Tunisia, 1994 | + + | + + | + + + | + | |
| Uganda, 1994 | + + | + + | | + | |
| Southern Africa, 1994 | + + | + + | + | + | + |
| Cambodia, 1994 | + + | + + | + | + | |
| China, 1993 | + + | + + | + + | + | |
| Israel, 1994 | + | + | + + + | + | + |
| Japan, 1993 | + + | + + | + + | + | |
| Sri Lanka, 1994 | + + | + + | + | + | |
| ESCAP, 1990 | + + + | + + + | + | + | + |
| Czechoslovakia, 1992 | + + | + + | | + | |
| Estonia, 1992 | + + | + + | + | + | |
| Poland, 1993 | + + | + + | + | + | |
| Ukraine, 1994 | + | + | + + | + | + |
| Austria, 1994 | + + + | + + + | + + + | + | |
| Finland, 1993 | + + + | + + + | + + | + | |
| Italy, 1993 | + + + | + + + | + + | + | + |
| Netherlands, 1995 | + + + | + + + | + + + | + | + |
| Nordic Countries, 1993 | + + + | + + + | + | + | + |
| Europe, 1995 | + + + | + + + | + | + | + |
| Canada, 1991 | + + + | + + + | + + | + | + |
| United States, 1993 | + + + | + + + | + + + | + | + |
| Mexico, 1994 | + | + + | + + + | + | + |
| OECD, 1991 | + + + | + + + | + + + | + | |
| UNEP, 1992 | + + | + + | + + | + | |

[1] Full citations for the national and international SOE reports listed are contained in Annex 1.

[2] A comparative code is used for environmental process: + little information; + + moderate information; + + + elaborate information.

[3] No report in the table extensively used an ecosystem framework as a structuring element. Various reports, such as those for Southern Africa, Netherlands, Canada, and Mexico, discuss selected ecosystems or make some use of ecosystems spatial frameworks.

**TABLE 3-4**

**STRUCTURING SOE REPORTS BY ECONOMIC SECTORS[1]**

| Selected Economic Sectors | Agri-culture | Fo-restry | Fish eries | Mi-ning | Ener-gy | Indus-try | Trans port | Tou-rism |
|---|---|---|---|---|---|---|---|---|
| Tunisia, 1994 | | | | | + | + | + | |
| Uganda, 1994 | + | + | + | + | + | + | + | + |
| Southern Africa, 1994 | + | + | | + | + | + | | |
| Cambodia, 1994 | + | + | + | + | + | + | + | + |
| China, 1993 | | | | | | | | |
| Israel, 1994 | | | | | | | | |
| Japan, 1993 | | | | | | | | |
| Sri Lanka, 1994 | + | | + | | + | + | + | + |
| ESCAP, 1990 | + | + | + | + | | + | | |
| Czechoslovakia, 1992 | + | | | + | | | | |
| Estonia, 1992 | | | + | + | | | | |
| Poland, 1993 | | | | | | | | |
| Ukraine, 1994 | + | | | | + | + | | |
| Austria, 1994 | + | | | | + | | | |
| Finland, 1993 | + | + | + | | + | + | + | |
| Italy, 1993 | + | | | | + | + | + | + |
| Netherlands, 1995 | + | | | | + | + | + | |
| Nordic Countries, 1993 | + | + | + | + | + | + | + | + |
| Europe, 1995 | + | + | + | | + | + | + | + |
| Canada, 1991 | + | + | + | + | + | + | | |
| United States, 1993 | + | + | + | | + | + | + | |
| Mexico, 1994 | + | + | + | + | + | + | + | |
| OECD, 1991 | + | + | + | + | + | + | + | |
| UNEP, 1992 | + | + | + | | + | + | + | + |

[1] Full citations for the national and international SOE Reports listed are contained in Annex 1.

**TABLE 3-5**

**STRUCTURING SOE REPORTS BY ENVIRONMENTAL MEDIA[1]**

| Environmental Media[2] | Air | Land | | | | Water | | Biota |
|---|---|---|---|---|---|---|---|---|
| | | Soil | For-ests | Farm land | Wet lands | Fresh | Marine | |
| Tunisia, 1994 | + | + | | | | + | + | |
| Uganda, 1994 | | | + | + | + | + | | + |
| Southern Africa, 1994 | | + | + | | + | + | + | + |
| Cambodia, 1994 | + | + | + | | + | + | | |
| China, 1993 | + | | + | + | | + | | + |
| Israel, 1994 | + | | | + | | + | + | + |
| Japan, 1993 | + | + | + | | + | + | + | + |
| Sri Lanka, 1994 | + | + | + | | | + | + | + |
| ESCAP, 1990 | + | + | + | + | + | + | + | + |
| Czechoslovakia, 1992 | + | | + | + | | + | | + |
| Estonia, 1992 | + | + | + | | | + | + | + |
| Poland, 1993 | + | + | + | + | | + | + | + |
| Ukraine, 1994 | + | + | + | + | | + | | |
| Austria, 1994 | + | + | + | | | + | | + |
| Finland, 1993 | + | + | + | + | | + | + | + |
| Italy, 1993 | + | + | + | | + | + | + | + |
| Netherlands, 1995 | + | + | | + | | + | | + |
| Nordic Countries, 1993 | + | + | + | + | + | + | + | + |
| Europe, 1995 | + | + | + | | | + | + | + |
| Canada, 1991 | + | + | + | + | + | + | + | + |
| United States, 1993 | + | | + | + | + | + | + | + |
| Mexico, 1994 | + | + | + | | | + | + | + |
| OECD, 1991 | + | + | + | + | | + | + | + |
| UNEP, 1992 | + | + | + | | + | + | + | + |

[1] Full citations for the national and international SOE Reports listed are contained in Annex 1.

[2] For national reports, this structuring is based on that used for the country itself, not for any discussion of regional or global issues.

**TABLE 3-6**

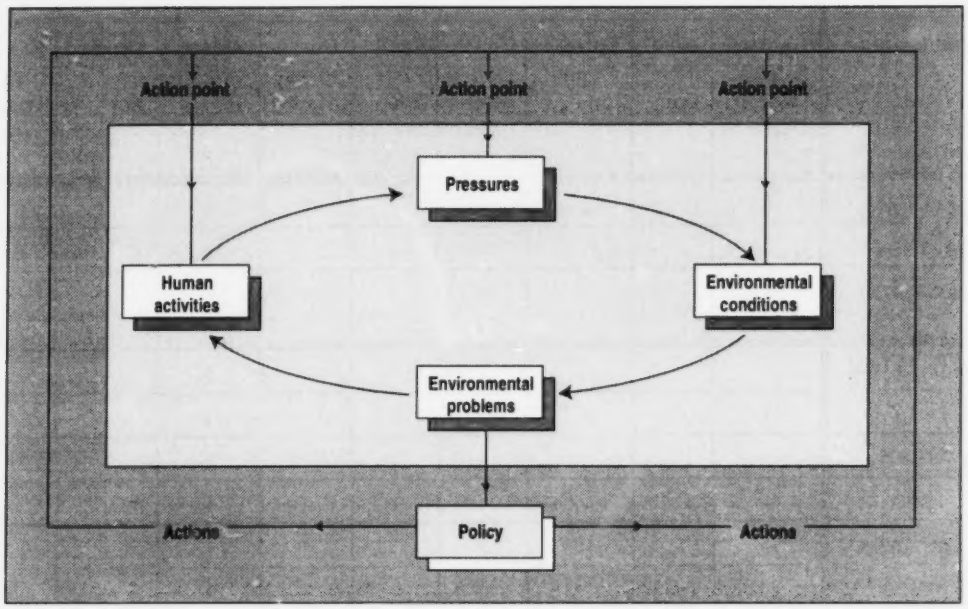
**STRUCTURING SOE REPORTS BY ISSUES[1]**

| Selected Issues | Climate Change /Ozone Depletion | Acidification | Eutrophication | Toxic Contamination | Land Degradation | Deforestation | Waste | Urbanization[2] | Bio diversity Loss |
|---|---|---|---|---|---|---|---|---|---|
| Tunisia, 1994 | | | | | + | | + | | |
| Uganda, 1994 | | | | + | + | + | + | | |
| Southern Africa, 1994 | | | | + | + | + | + | | |
| Cambodia, 1994 | | | | + | + | + | + | + | + |
| China, 1993 | + | | | + | + | | + | + | |
| Israel, 1994 | + | | | + | + | | + | + | + |
| Japan, 1993 | + | + | | + | + | + | + | + | + |
| Sri Lanka, 1994 | + | | | + | + | + | + | + | + |
| ESCAP, 1990 | | | | + | + | + | + | + | + |
| Czechoslovakia, 1992 | | | | + | + | + | | | |
| Estonia, 1992 | | | | | | | + | | |
| Poland, 1993 | + | | | | + | + | + | + | + |
| Ukraine, 1994 | | | | + | + | | + | | |
| Austria, 1994 | | | | + | | | + | + | + |
| Finland, 1993 | + | + | + | + | | + | + | + | + |
| Italy, 1993 | + | + | | + | + | + | + | + | + |
| Netherlands, 1995 | + | + | + | + | + | | + | + | + |
| Nordic Countries, 1993 | + | + | + | + | + | + | + | + | + |
| Europe, 1995 | + | + | + | + | + | + | + | + | + |
| Canada, 1991 | + | + | | + | + | + | + | + | + |
| United States, 1993 | + | + | + | + | + | + | + | + | + |
| Mexico, 1994 | | + | | | + | + | + | + | |
| OECD, 1991 | + | + | + | + | + | + | + | + | + |
| UNEP, 1992 | + | + | + | + | + | + | + | + | + |

[1] Full citations for the national and international SOE Reports listed are contained in Annex 1.

[2] Includes noise and air quality.

**Figure 3-5**
**The Analytical Structure of the Dobris Assessment**




Source: Stanners & Bourdeau, 1995

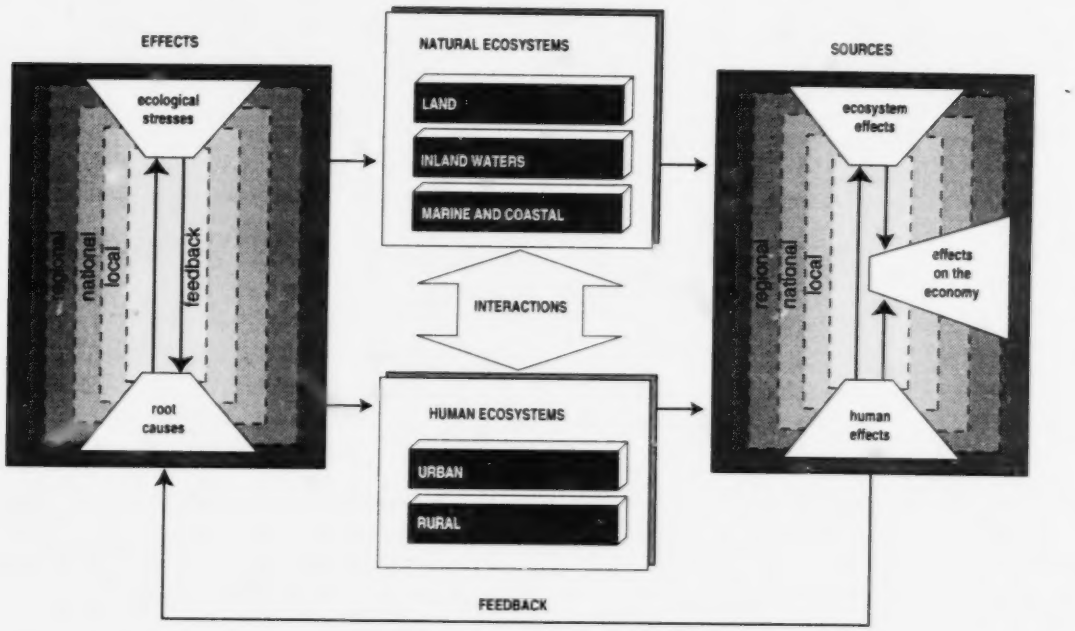
In the *State of the Environment in Asia and the Pacific 1990*, both the notion of cause-effect and the spatial context are recognized and influence the structure of the document (Economic and Social Commission for Asia and the Pacific, 1992). The interactions between the *natural ecosystems* of land, inland waters, and the marine environment; and human urban and rural ecosystems are examined according to sources and effects (see Figure 3-6). *Sources* are considered as root causes which result in stresses affecting natural ecosystems. Three categories of *effects* are recognized: ecosystem, health, and economic. The *spatial dimension* is included in this conceptual framework to show the interaction of environmental change at different levels. This helps to emphasize the potential transfer of both sources and effects from local to global scales. The model draws attention to the importance of feedbacks and interactions among sources and effects at the various regional levels.

This conceptual framework is translated into an organizational framework for the report in Figure 3-7. The first part of the document assesses the prevailing *environmental conditions* in both the natural and human ecosystems according to biophysical status and social well-being respectively. In the second part, the human perception of environmental conditions and the resulting national and regional *responses* are discussed. Solutions to environmental problems are presented in terms of strengthening institutional capabilities, enacting legislation, promoting environmental education and public awareness, applying appropriate technologies, and incorporating environmental considerations in development planning. In the final part of the report, regional trends and projections, the regional implications of global environmental problems, and environmental challenges are examined to provide the context for policy decision making.

Currently, ESCAP in cooperation with its member countries is completing a third regional SOE assessment for Asia and the Pacific. The overall structure of this report will focus on environmental conditions and trends, causes and consequences, responses, and challenges

and opportunities in a sustainable development context (Economic and Social Commission for Asia and the Pacific, 1994). From a spatial perspective, the report proposes to concentrate on sub-regional groupings, areas with a common ecological setting, and groups of countries with similar development challenges.

**Figure 3-6**
**Conceptual Framework Used by ESCAP**

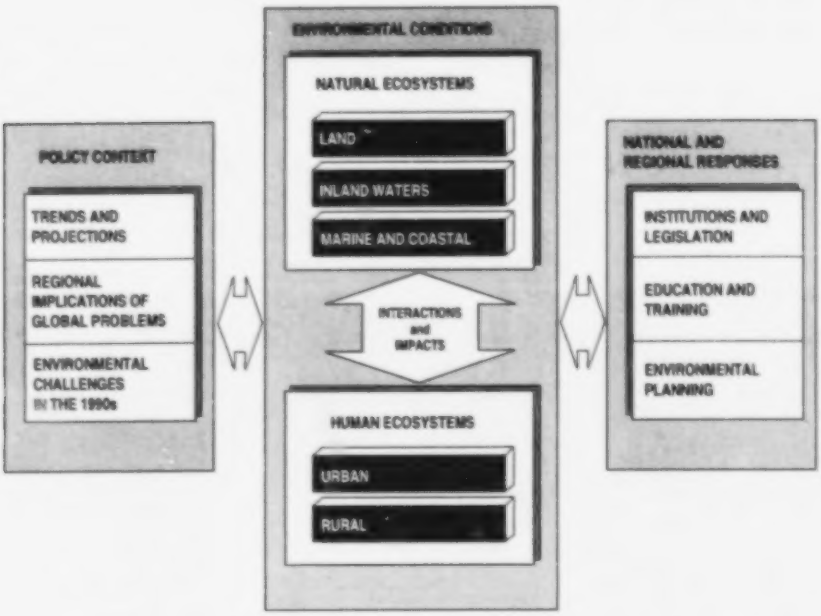



Source: Economic & Social Commission for Asia & the Pacific, 1990

In *Canada,* three national state of environment reports have been produced, with a fourth in an advanced stage of production (see Box 7-1). By considering this series, a progression from a simple, descriptive issue analysis towards integrative and comprehensive reporting using a pressure-state-response organization within ecologically defined regions is evident. The first effort to report on Canada's state of the environment was completed in 1976 by members of a ministerial advisory committee writing selected essays on significant *contemporary issues* (Canadian Environmental Advisory Council, 1976). Although a pioneering report aimed at raising public awareness, it cannot be regarded as a comprehensive, structured model to meet today's needs for integrative sustainable development decision making.

In 1986, the first comprehensive national SOE report was produced for Canada (Environment Canada, 1986). It was authored by two government scientists from Statistics Canada and Environment Canada, with the support of external consultants and expertise from within the two government agencies. This report attempts to apply an *ecosystem approach* to discuss environment-development interactions, but problems related to data availability precluded the complete adoption of such a spatial framework to the organization and contents of the report. Consequently, the report uses a mixture of jurisdictional, river basin, and ecozone units to discuss the state of the environment.

**Figure 3-7**
**Organizational Framework used by ESCAP**




Source: Economic & Social Commission for Asia & the Pacific, 1990

Canada's 1991 national SOE report exemplifies the adoption of the *pressure-state-response* model. Moreover, the ambition of a fully integrated ecosystem approach is espoused in the report's introduction. However, this blue print is only partially delivered in the main body of the report which is composed of three parts discussing *human activities and environmental media, current issues,* and *regional case studies*. It is only in the regional case studies that ecosystems thinking comes to the fore. This project made significant efforts to involve all stakeholders in the reporting process to achieve a balanced and widely accepted assessment.

The 1996 national assessment, currently under production, builds on the experience of the previous reports to produce an *integrated pressure-state-response assessment within an ecosystem spatial framework*. To support such an approach, it has been necessary to complete a collaborative project to update and finalize the terrestrial and marine ecosystems spatial framework and provide the necessary linkages to federal and provincial databases (Marshall and Scott Smith, 1995). This national report will complement provincial and local reporting in Canada by providing a state of the environment assessment at the ecosystem level for the whole country. It will allow the assessment of the carrying capacity and health of ecosystems and should sensitize decision making with respect to sustainability.

# IV THE DATA FOUNDATION

## 1 The Data Problem

Robust environmental and socioeconomic data provide the foundation for the analysis and interpretation of the state of the environment. In the absence of such data, SOER is reduced to descriptive, anecdotal, and non-systematic observation; not an acceptable basis for rational decision making. The type of data required covers a wide spectrum. Data on natural resource stocks and environmental conditions are essential. However, statistics on human activities impacting on the environment, the emission of pollutants, natural events, and human responses to environmental change are equally important if we wish to assess ecosystem interactions (Hamilton, 1991).

Under sustainable development, with a conceptual framework such as an ecosystem based pressure-state-response approach and a listing of priority issues, we should be in a position to more specifically determine data requirements. However, countries and international organizations responsible for SOER programs start with the reality that the data for environmental assessment are not easily accessible or well consolidated. Typically, a mosaic of data holdings exists in any one region. Environmental and socioeconomic data tend to be collected independently by diverse agencies, using different methods and classifications, and for quite specific purposes.

Data on the environment itself are usually derived from monitoring programs and the interpretation of remotely sensed images. Socioeconomic data tend to be collected from statistically designed surveys. From a state of the environment perspective, particularly at national, regional, and global levels, the spatial resolution and temporal dimensions of much of the data are often limited. Much of the available data relate to individual environmental or human activity components rather than a synergistic, ecosystem perspective. For example, databases for commercial forest areas tend to emphasize the production mandate of the forestry management agency; not adequately reflecting the diverse values of forest ecozones which include their role in terms of habitat and biodiversity, water conservation, and traditional and alternative land uses.

Under these circumstances, do we need more data or should we use existing data more efficiently? Some people would contend that we have insufficient data, others that we have too much. We know comparatively little about the biota of the planet, particularly microorganisms, yet we have masses of raw data coming to earth from observation satellites on a daily basis. Our databases for social, economic, and demographic conditions and trends are relatively well developed and integrated compared to environmental statistics. However, it is clear that we do not have adequate and accurate data to answer some basic questions related to sustainability. Data limitations, both in terms of balance and quality, severely hinder the quantitative assessment and reporting of the state of the environment. In today's world, data must support the development of more holistic information, understanding, and knowledge. The barriers and data limitations to such information can be summarized under four points (Needham, 1992):

- data quantity and quality;
- data access and dissemination;
- data synthesis and integration; and
- data comparability.

Although high-quality data are vital for credible information, a systematic approach to their generation is largely lacking. The acquisition, processing, and storage of environmental data is time consuming, expensive, and not a priority for most governments. Consequently, there are insufficient baseline and trend data related to the ways ecosystems function and their components interact. The data we do have tend to be scattered and difficult to obtain, while proprietary and security factors can inhibit dissemination and open access. Environmental and socioeconomic data do not generally exist in useable and integrated formats for reporting. There is a common deficiency of infrastructure and standards to facilitate the easy exchange and correlation of data from different jurisdictions and disciplines.

What can SOER agencies do to improve this situation recognizing that they are usually not primary data gathering institutions? The various sources of environmental data include bodies responsible for environmental and resource monitoring, statistical surveys, and mapping and remote sensing. There is no quick fix solution, but many agencies are taking immediate and longer term steps to consolidate data to facilitate more efficient and effective reporting. There is a basic choice between designing from the outset a new monitoring and data processing system based on ecosystems to allow the reporting of environmental conditions and trends; or incrementally adapting existing monitoring and survey systems to meet today's more holistic needs. Both approaches have been proposed. The suggestions in this chapter tend to be modest and are primarily directed at building upon existing data and data gathering networks to improve access and dissemination. This approach is seen as being more practical and more suited to the resource realities faced by most national and regional reporting programs.

The following sections focus on three areas to improve environmental data for SOER purposes: **database development; use of geographic information systems**, and **creation of an environmental information systems capability**. Progress in these areas will increase efficiency, improve data management, support analysis and interpretation functions, foster cooperation between data holders and users, facilitate greater harmonization and comparability, and create a firmer base for continuous reporting. Emphasis on capacity building may be necessary to achieve such progress (see Chapter II).

## 2 Database Development

For a new SOER program, a focus on existing monitoring and survey systems will be appropriate in the short term to evaluate the data available and its suitability for reporting purposes. It is recommended that the formation of a **meta-database**[1] for SOER represents an early step in the process. The organization and scope of such a reference database should be determined by the objectives and conceptual framework of the reporting program itself. Knowledge of the priority issues and the selection of a pressure-state-response framework, for example, will help structure a survey of data generating agencies.

In a broad context, a useful environmental meta-database could include information on institutions, research, legislation and regulations, expertise, and available reports (United States Geological Survey and United Nations Environment Programme, 1993). However, for SOER, it is critical to build a meta-database on environmental and related socioeconomic data which quantify the state and changing condition of the environment.

---

[1] A database reference system or inventory providing information on database characteristics such as purpose and content, data acquisition methods, units of measurement, geographic and temporal coverage, update frequency, output format, conditions of use, contact point, etc.

Regularly updated databases where temporal trends can be examined would be of particular value. Other databases useful in providing a baseline also warrant inclusion. The storage format should not be a criterion for the selection of databases. Data from analogue sources may be just as valuable as machine readable formats. As a general rule, the spatial coverage of the database should match the region of the reporting agency.

The sources of such data will include international agencies, national departments, local and state governments, NGOs, universities and research organizations, and business associations. In a generic sense, the information required from a meta-database survey will be derived from the following questions (see United States Geological Survey and United Nations Environment Programme, 1993; and Statistics Canada and Environment Canada, 1992):

- What parameters are measured? For what purpose?
- How was the measurement done? Have the data collection methods,classifications, or definitions changed over time?
- When and where was the measurement done? What is the period of record and the update frequency? What is the geographic coverage? What spatial units are used?
- Who performed the measurement?
- How are the data stored? Are the data georeferenced?
- What output formats are possible?
- What background documentation and user aids are available?
- Who holds and manages the data? Who is the appropriate contact person?
- How can the data be accessed and are there any restrictions on use?

Several national and international agencies have established such meta-databases related to SOER. Clearly, the availability of such a tool not only assists the SOE agency and its staff, but also the wider community. In this sense, the meta-database becomes an SOER product itself with external value. It can, for example, be a useful tool in encouraging cooperation to fill critical data gaps and adjust monitoring programs.

Once established, the meta-database requires up-dating as a quality control measure to maintain currency. From an operational viewpoint, this should be completed on a continuous basis with the meta-data forming an integral part of an overall SOE database. Up-dating will require less time and resources than the initial survey.

With the availability of a SOER meta-database, the assembly of the actual data required for reporting purposes can begin. It is recommended that only the data required for specific reporting needs or products be acquired to avoid extra work and undue duplication. This may require considerable processing or reformatting to obtain suitable data to interpret environmental conditions and trends. Remote sensing data, for example, has great potential to detect change, but requires interpretation which can be costly. Census statistics may be readily available, but require reprocessing to generate data suitable for state of the environment analysis.

In the development of an **SOE database** it is useful to determine the core set of data needed as the base for reporting. The core set should be organized to support regular comprehensive assessments or the development of multiple reporting products. General guidance on what could be considered as core data for environmental assessment purposes at national and international scales is listed in Table 4-1. A more specific illustration of data needs for SOER is listed in Table 4-2.

**TABLE 4-1**

**CORE DATA FOR ENVIRONMENTAL ASSESSMENT**

| | |
|---|---|
| • Land Use/Land Cover | • Topography |
| • Demographics | • Economy |
| • Hydrology | • Soils |
| • Infrastructure | • Air Quality |
| • Climatology | • Water Quality |

Source: United Nations Development Programme and United Nations Environment Programme, 1994.

If all sectors, multi-levels of government, or several countries are involved, a **data questionnaire** can be used to good advantage to stimulate the development of integrated environmental databases at both regional and national levels (See Box 4-1). Such a questionnaire should focus on those data that cannot be acquired more directly from published or centralized data sources. Alternatively, it may be possible to use existing surveys to generate new information suitable for SOER. Existing municipal or industrial surveys conducted by statistical agencies could, for example, provide the vehicle to obtain otherwise scarce data on waste and waste treatment. In addition, household surveys can be used to determine consumption patterns and conservation measures (Needham, 1992).

To be cost effective, the development of an SOER database should be accomplished in conjunction with the planning and production of reporting products. The phasing and interlinkage of database and product are illustrated in Figure 4-1 for the initial cycle of a new program. Subsequent cycles should require less effort, even allowing for data assessment, and questionnaire and database revision activities.

In the development of databases for SOER, four factors warrant particular attention:

- **relevance**: this can be judged against the objectives, conceptual framework, and priority issues recognised by the SOER program.
- **validity**: the data selected must be valid for the phenomenon being described.
- **reliability**: information from the meta-database on data source, data collection methods, bias and error estimates, consistency controls, and definitions will help provide a reading on reliability.
- **comparability**: careful comparison between data sets showing different results will be necessary to obtain the most credible source.

**TABLE 4-2**

**SPECIFIC DATA NEEDS FOR STATE OF THE ENVIRONMENT REPORTING**

**Driving Forces:**
- Demographics (e.g. total population, growth rates, population density, rural-urban migration)
- Poverty and social development (e.g. population below poverty line, employment, education)
- Technology, trade and lifestyle (e.g. research and development capacity, imports and exports of natural resources, commodity consumption rates)

**Human Activities:**
- uses of environmental resources (e.g. land use, water use)
- consumption of natural resources (e.g. forest harvest, fish and wildlife take, loss of habitat, mineral extraction)
- management pattern (e.g. intensity, monoculture)

**Stresses:**
- levels of contaminants in the environment (e.g. dioxin, nitrates, sulphur dioxide, leachates, etc. in air, soil, water, and biota)
- sources of contaminants (e.g. industrial and municipal sources, non-point sources, processes creating contaminants)
- human activity stresses (e.g. waste levels, urbanization, transportation, ocean spills)

**Components of the Environment:**
- biological and physical characteristics of the atmosphere, hydrosphere, lithosphere, and biosphere (e.g. climate, chemistry, physical properties)
- biota (e.g. presence, diversity, numbers)
- resource capability (e.g. land capability, water recharge capability)

**Ecological Responses to Stresses:**
- changes in the environment (e.g. global warming, acid rain, loss of biodiversity, land degradation, bio-magnification, cultural and aesthetic impacts)
- human health effects (e.g. incidence rates, geographical distribution, etc.)

**Management Response:**
- activity measures (e.g. protected areas, sites rehabilitated, recycling rates, sewage treated, trees planted, etc.)
- energy and water use/efficiency (e.g. plant and production processes, appliance efficiency, changes in renewable/nonrenewable mix, public/private transport use)
- institutional response (e.g. regulation, policy development,taxation and subsidies, use of economic instruments)

Source: Adapted from Table 27.4, Government of Canada, 1991; and United Nations Environment Programme, 1994d.

**BOX 4-1**

**DATA QUESTIONNAIRES FOR STATE OF THE ENVIRONMENT REPORTING**

**Organisation for Economic Co-operation and Development**

The purpose of this questionnaire is to collect the best available data on the environment from member countries and to promote international harmonization of these data. It is administered in cooperation with Eurostat. The information from the questionnaire, together with information available from other sources, is used to:

- support the development of an OECD database;
- contribute to the publication of regular statistical compendia;
- contribute to reporting, including the development of environmental indicators.

The initial version of the questionnaire was developed in 1980-81. Since 1984, it has been completed on a two year cycle. During this time, the questionnaire has been revised three times to reflect changing priorities, classification and definition development, progress in member countries, and the need for comparability and trend identification.

The underlying structure behind the questionnaire is the pressure-state-response framework. Its contents are determined by availability and relevancy of data. The questionnaire requests data under eight topic areas: air; inland waters; marine environment; land; forests; wildlife; waste; and noise.

**United Nation Environment Programme**

The Asia and Pacific Region of UNEP is currently establishing an integrated environmental database for state of the environment reporting. The program is in response to the Agenda 21 call for improved data collection and presentation. The current sources of data include international databases and national data sets. A data questionnaire is being used to assemble national data. Its scope is determined by priority issues which have been established through consultation with nationai governments and regional organizations. An extensive capacity building program supports this initiative to help government agencies complete the inventory and use the resulting database.

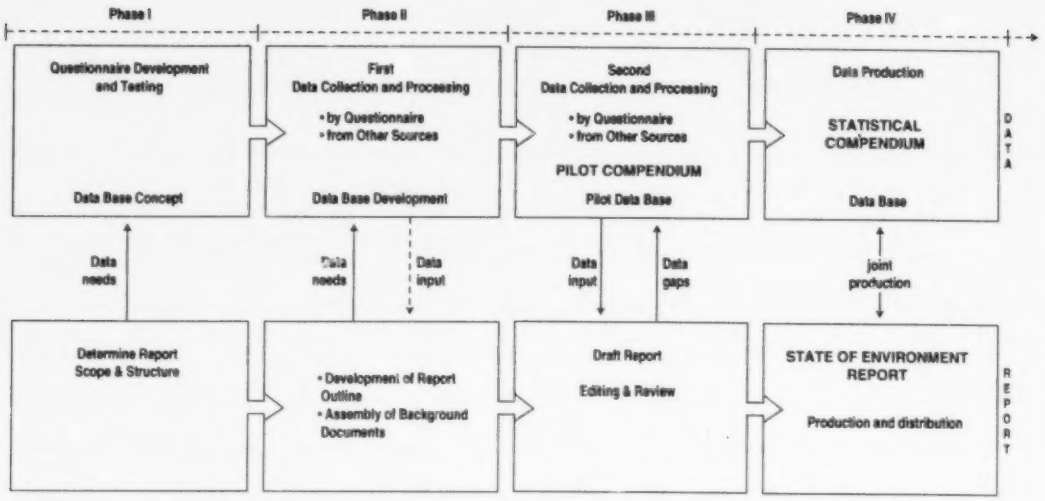
The questionnaire and database will serve to:

- facilitate national, regional, and global assessment and reporting;
- assist indicator development; and
- encourage linkages and data exchange among agencies.

The aim of this first questionnaire is to provide an initial inventory which will enable an assessment of data availability and data gaps. It is based on a series of tables covering the biophysical environment, socioeconomic data, natural disasters, and policies and institutions. Land, water, atmosphere and climate, and biodiversity are included under the biophysical environment; while population, education, poverty, health, agriculture, tourism, transportation, energy, industry, and economy and employment are recognised as the socioeconomic components. A final table ranks emerging environmental issues. The tables request annual data for the period 1984 to 1994. Updates are planned at regular intervals.

Sources: Organisation for Economic Co-operation and Development and Statistical Office of the European Communities, 1994; United Nations Environment Programme, 1994d.

**Figure 4-1**
**Linkage between Database & Report Development**




Adapted from: Organization of Economic Co-operation & Development

Data from surveys using standard and widely accepted definitions and classifications should be used to the extent possible to maximize comparability. For data from different sources, areas, or time series, changes in data collection methods, definitions, or classifications will affect reliability and comparability. For reporting purposes, adjustments should be made to bring consistency to the total record wherever possible.

Any SOER database will be ultimately constrained by what is available. In order to move towards the most robust data mix, a periodic assessment of the database for SOER purposes will be required. A possible framework for such an analysis is suggested in Table 4-3. This type of database assessment will facilitate the adjustment of data questionnaires, stimulate the improvement of data comparability, and give impetus to the acquisition of new data to fill gaps. The ultimate aim of such an assessment is, of coarse, to improve the database for decision making purposes.

To provide wide access to environmental databases, several countries and international organizations have published, in print or electronic form, compendia of environmental statistics. These reports, characterized by data presentation rather than interpretation and analysis, provide a complementary product to the SOE report itself (See Chapter VII). Such a product facilitates the dissemination of the full range of statistics; and provides a vehicle to review the sources, methods, and reliability of the data used. Examples of recent compendia of environmental statistics at national and regional level have been published by Mexico and the European Community (Instituto Nacional de Estadística, Geografía e Informática, 1995; Eurostat, 1995). At the global level, UNEP's *Environmental Data Report*, produced biannually, used to serve a similar function (United Nations Environment Programme, 1993c).

Over the longer term, it will be necessary to use new approaches to provide the kind of integrated data required to adequately assess and report on ecosystem sustainability. Two avenues for improved data that SOER agencies should explore through collaboration are **remote sensing** and **integrated monitoring.** SOER agencies, as users not primary data

generators, could benefit from cooperation with national and international remote sensing and monitoring agencies to determine the feasibility of acquiring new data for priority areas.

**TABLE 4-3**

**MATRIX FOR THE ASSESSMENT OF AN SOE DATABASE**

| SUBJECT AREA | ASSESSMENT CRITERIA | | | |
|---|---|---|---|---|
| | Relevance | Validity | Reliability | Comparability |
| Air and Climate | 4 | 3 | 4 | 4 |
| Water | 3 | 3 | 3 | 4 |
| Land Use/Cover | 1 | 2 | 2 | 2 |
| Soil | 3 | 3 | 2 | 3 |
| Biota | 2 | 2 | 1 | 2 |
| Demographics | 5 | 4 | 5 | 5 |
| Economy | 4 | 3 | 4 | 4 |
| Topography | 4 | 5 | 5 | 4 |
| Infrastructure | 3 | 3 | 4 | 3 |
| Waste | 2 | 2 | 1 | 1 |

Rating: 0 is very low; 5 is high or excellent.

The completion of the matrix is for illustrative purposes only.

**Remotely sensed data** have considerable potential for providing time series data on environmental conditions for large areas (Intera Information Technologies, 1992). The current satellites and sensors most frequently used for environmental applications include the National Oceanic and Atmospheric Administration's (NOAA) Advanced Very High Resolution Radiometer (AVHRR), the Landsat Thematic Mapper (TM), and the Système Probatoire d'Observation de la Terre (SPOT). AVHRR, primarily a meteorological satellite, provides frequent, inexpensive, coarse resolution imagery that can be used to show vegetation under stress or deforestation. Landsat TM data with higher spectral resolution, good spectral definition, and less frequent coverage can be useful for vegetation and water applications, and land cover mapping, although at a higher cost. SPOT provides the most detailed data in terms of spatial resolution, and can be used for land use change detection. These advantages are tempered by high cost for large area applications. In the 1990s, these satellites will be augmented by radar satellites from Europe, Japan, Russia, and Canada (Needham, 1992). Such sensors have the great advantage of cloud penetration, a key factor in such areas as tropical forests.

Despite the volume and potential of such data, few large scale change data sets suitable for SOER programs are presently derived from remote sensing. In fact, it has been estimated that only about 5% of Landsat images are used for any purpose (Rodenburg, 1991). Obviously, SOER agencies are not in a position to unilaterally transform this situation. However, it may be possible for an SOE program to use remote sensing data to selectively fill gaps through partnerships and cooperation.

The traditional sectoral approach to **monitoring** is well documented (Ward, 1991). Such monitoring is usually not representative of all ecosystems, not well adapted to provide early warning of emerging problems, or adequate to track the cumulative effects of numerous incremental changes. The goal of moving towards an integrated monitoring capability over the long term is well established. Integrated monitoring represents the key to the understanding of ecosystems dynamics, integrity, and health. It implies the measurement of a wide range of co-located and synchronous parameters related to ecosystem components allowing greater harmonization of data, the analysis of linkages and changes, and consistent reporting. Integrated monitoring is generally seen as a complement, rather than a replacement, to sectoral monitoring.

Two basic approaches can be used to establish an integrated monitoring capability. The Environmental Monitoring and Assessment Program (EMAP) in the United States is designed as a national monitoring system to provide fundamental, long term data on the status, condition, and trends of the nation's ecological resources. The program is based on data gathered from a statistically designed sample of sites determined from a nation-wide grid. Recent evaluations of the program, however, have called for more in-depth measurement at fewer sites (Reichhardt, 1995).

This more modest, selective approach is being used or considered by other countries such as Sweden, Canada, and Venezuela. The approach has also been proposed for monitoring global change (Bailey, 1991; Bashkin and Bailey, 1993). It relies on the spatial classification of ecosystems to facilitate the selection of representative monitoring sites. This does not necessarily imply major expenditures for new sites or facilities. Rather, the approach builds on established monitoring and research programs and facilities, emphasizing integration and partnerships of social, economic, biological, and physical disciplines. A limited network of integrated monitoring and research centres would be established based on the country's ecological regions. Criteria for the selection of such centres would include long-term security, ecosystem representivity, existing data record, and existing logistical support. Such centres could be locally managed, but national guidance would provide common standards and encourage cooperation and communication (Roberts-Pichette, 1994).

## 3 Spatial Data

Spatially referencing data can make them more useful for environmental assessment and reporting purposes. In the case of socioeconomic statistics, spatial referencing of census data facilitates mapping the environmental impact of human activities (Hamilton, 1991). Indeed, maps are regarded as an essential tool for assessing the state of the environment and progress towards sustainability (United Nations Development Programme and United Nations Environment Programme, 1994).

Today, static maps and atlases are evolving into dynamic Geographic Information Systems (GIS). This technology offers the capability of storing, retrieving, analysing, manipulating, integrating and displaying large amounts of environmental and socioeconomic data in a single system (Ford et al, 1990; Bernhardsen, 1992). With donor support, it is potentially available to all countries at reasonable cost (United Nations Environment Programme, 1990). User-friendly systems are now commercially available for personal computers: the choice depending on the user's need for data management, display, analysis, and modelling. The primary limiting factor is usually the availability of base and thematic maps in digital form.

In summary, GIS facilitates:

- overlays of data for purposes of integration and comparison;
- updating of data to illustrate changes over time;
- the accommodation of a variety of scales;
- manipulation to produce new interpreted information;
- incorporation of remotely sensed data; and
- analysis and modelling capability.

One of the most important features of a GIS is its ability to portray tabular, numerical data in map and graphic formats. Spatial data sets can be converted to the same scale. Such harmonization allows the overlay of different data sets for the analysis of the interaction of many parameters, typically relevant to many environmental issues (United Nations Environment Programme, 1990). For example, soil capability, slope, rainfall, land cover, and land use can be used to derive a map of soil erosion. In addition, the archival and updating capabilities of GIS are important for reporting purposes, allowing the analysis of temporal trends. With a GIS, a series of land use inventories becomes more useful as a land use change database.

The move from statistical to spatial analysis, from data to maps, takes time and occurs incrementally. As noted above, adequate digital base maps are not available in many countries. In addressing this situation, the question of scale for the digital base maps becomes an important consideration. Obviously, the larger the scale, the more resources and time are required to achieve full coverage for a country or region. Experience in relatively large countries like Mexico and Zambia suggests that the first priority should be given to completing national coverage quickly using a scale such as 1:1 million (Chipungu and Kunda, 1994; F. Takaki, personal communication).

To improve base map availability in Africa, the World Resources Institute (WRI) has initiated a project to develop and distribute an internationally comparable set of digital base maps for all countries (See Box 4-2). Other countries are building up their capacity to use GIS for reporting purposes. Mexico now has the capacity to bring environmental statistics, GIS, and SOER together through the cooperation of the national environment and statistical agencies. The important point is to begin to take advantage of opportunities to build experience. Venezuela, for example, for its first national SOE report, used existing GIS capacity to digitize protected area maps. This step will provide the baseline for future reporting while beginning the larger task of creating a more comprehensive spatial database for the analysis, interpretation, and presentation of environmental conditions and trends. Uganda, for its 1994 SOE report, used GIS to digitize dated, but valuable information on farming systems, ecological zones, and other important environmental and land use patterns (Uganda Ministry of Natural Resources, 1994). Zambia has effectively demonstrated how GIS thematic maps can improve its national SOE report (Chipungu and Kunda, 1994). In other cases, such as Poland, the development of GIS databases already plays a more prominent role in SOE products (See Box 4-3). There are a few examples of extensive GIS databases which have the potential to serve SOER purposes. These would include the CORINE programme of the European Community and the Environmental Assessment and Reporting Support System being developed by UNEP GRID-Bangkok for the Asia-Pacific region (Commission of the European Communities, 1993; Fedra, 1994).

**BOX 4-2**

**DIGITAL BASE MAPS FOR AFRICA**

**Background**

There is a growing demand for maps and a growing capacity to use digital spatial data in many African countries. However, the main stumbling block is the paucity of mapped information, especially up-to-date national base and thematic maps. To begin to fill this gap, the World Resources Institute has just completed the African Data Sampler project to provide a set of international comparable maps at the scale of 1:1 million for all 53 African countries. The objective of this prototype is to increase the availability of standard data, thereby providing a spatial tool for high quality presentation and reporting in a decision making context. It should be emphasized that the Sampler does not represent a comprehensive spatial database, but it is hoped that this initial encouragement will act as a catalyst for countries to build on by adding national data sets to create an integrated spatial database for visualization, analysis, and reporting. With the use of the compatible base maps from the Sampler, it will be possible to combine maps from various countries to create regional maps and databases.

**The African Data Sampler**

The African Data Sampler integrates several data sets derived from a variety of sources for each country. It is based on the Digital Chart of the World for data on drainage, topography, and infrastructure. Additional data on protected areas, forests, mangroves, and wetlands come from the World Conservation Monitoring Centre, while sub-national regional boundaries and demographic statistics are provided by the National Centre for Geographic Information and Analysis. The data sets are stored as georeferenced maps with corresponding tabular data.

These country databases are aimed at three broad types of users: policymakers and other non-GIS experts who wish to view, analyze, and print simple maps; policy analysts who can integrate the Sampler maps with their own digital maps to increase the analysis capability; and GIS specialists where more advanced data manipulation through overlays and integration, can provide improved analysis and cartographic output.

The Sampler represents a starting point at providing integrated, comparable information. It should not be viewed as a definitive database, but rather as a base to build on by adding other themes, improving accuracy, and providing change data sets. Thus, the Sampler could act as a impetus to develop a quantitative, spatial capability to report on conditions and trends in the state of the environment.

Data samplers for individual countries are available on diskette, while the complete set for Africa as a whole is available in CD-ROM format. The data sets are provided in PC ARC/INFO format and commercial software should enable conversion to other software, including common GIS packages.

Source: World Resources Institute, 1994a.

**BOX 4-3**

**GIS USE FOR STATE OF THE ENVIRONMENT REPORTING**

**Background**

In 1985, the United Nations Environment Programme established the Global Resource Information Database (GRID) to collect, process, and disseminate spatially referenced information concerning the environment and natural resources. GRID operates as a network of cooperating centres. The system collectively houses over 2000 digital environmental data sets with scales ranging from sub-national to global.

In 1991, GRID-Warsaw was created as a GRID resource centre for environmental information with a focus on Poland and Eastern Europe. The centre works in close collaboration with the Polish State Inspectorate for Environmental Protection. In its short history, the institution has developed a catalogue of data sources, initiated the development of a central environmental database, attained remote sensing and GIS capability, and published a state of the environment report for Poland.

**Polish SOE Report**

The *State of Environment in Poland* was published in 1993. It reports primarily on environmental media such as air, soils, and water; and on environmental issues such as waste, climate change, and radioactivity. Protected areas and land use are also discussed. An important characteristic of the document, one which distinguishes it from previous Polish SOE reports, is the cartographic presentation of the findings. More than 35 national maps are included in the report; most of them generated by GIS. The subject of some of the major maps include: population density, land use, protected areas, forests, agricultural land capability, soils, ground water quality, and ecological hazard areas. The maps provide the visible summary resulting from the compilation and processing of a large amount of data. Thus, the maps were instrumental in presenting complex information in a meaningful and easy to understand way. In addition, they represent a solid base of overlays on which to build for multi-purpose spatial analysis. The maps and other information from the report have been packaged in digital form aimed at younger users familiar with computers.

Other activities of the centre contribute to systematic and quantitative reporting on the state of the environment. The development of the meta-database system and the central environmental database are particularly important. The spatial databases are either derived from other institutions or result from centre projects. The computerized thematic mapping not only contributes to SOE reports, but is also used for the national atlas and other products.

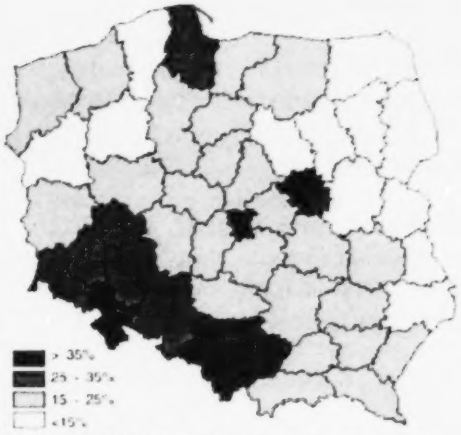
This first SOE report of GRID-Warsaw is seen as a prototype to build on for continuous reporting. Efforts in the future will focus on providing spatial information according to natural units, updating data, and providing consistent time series information. In this way, Poland will be in a good position to meet national, European, and global demands for environmental information.

Sources: Andrzejewski and Baranowski, 1993; United Nations Environment Programme, 1993b.

**BOX 4-3 (Cont.)**

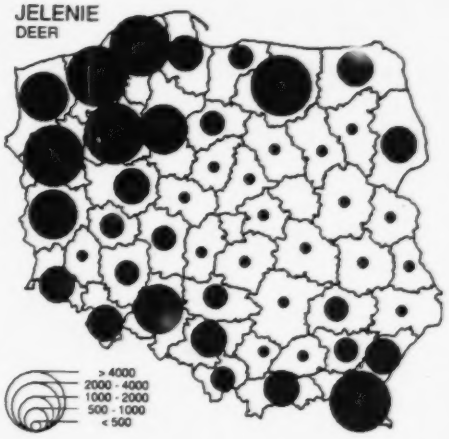
**GIS USE FOR STATE OF THE ENVIRONMENT REPORTING**

The hazard of noise exceeding the norm (over 60 Db)




According to date from the Acoustic Department of Building Research Institute. Elaborated by computer means, UNEP/GRID Warsaw

Number of shot deer in 1991/92




According to data from the Central Statistical Office. Elaborated by computer means, UNEP/GRID-Warsaw

## 4 The Development of an Environmental Information System (EIS)

Bringing together integrated monitoring and databases, remote sensing and GIS capability, quality control and standard setting, and the communications networks for data sharing and access requires the development of a data network and management infrastructure. Such an EIS should be based on georeferenced and systematically stored data for rapid access and use; integrated databases; and infrastructure management to set standards, and ensure compatibility of hardware and software (Collinson, 1994).

The main functions of such an information system in an SOER context should be to: facilitate public access to environmental information and data sharing; promote the integration and harmonization of data through the use of GIS and other means; and improve the consistency and efficiency of responses to requests for data from other levels including sub-national and international reporting. The establishment of such a system implies the designation of an institutional centre for management and coordination purposes (See Chapter II).

One of the prime considerations in the development of an EIS will be to avoid unnecessary duplication of databases . The design and content of the system must be driven by SOE requirements for data, rather than the available data supply. The system should not independently develop to maintain a large number of primary data sets. This focus is possible if the EIS has the scope to establish meta-databases, provide referral linkages between existing data systems, and incorporate and integrate core data sets using ecological and administrative spatial frameworks. The core database should contain only selected processed data, integrated at a level of aggregation appropriate for SOER. As the system develops, it would also incorporate any derived data sets generated for specific SOE projects for future trend analysis.

Mechanisms for quality control and standard setting should be within the purview of an EIS centre to achieve the required data quality, consistency, and comparability. Guidelines and protocols for data management would be developed as an integral part of the EIS. GIS capacity to access, integrate, link, and analyze socioeconomic and environmental data represents an essential component of any EIS for SOER. It provides the interpretation and assessment capability to link data generators and users. In addition, the EIS should contain a report generating, management, and archival capacity for SOER.

From a user perspective, the EIS should provide efficient retrieval, analysis, interpretation and presentation of data. This can best be achieved with on-line user access through local or wide area networks. In addition, a training and capacity building function would be an advantage to solidify the culture required for a sustainable EIS.

It is recommended that an EIS for SOER be developed using a staged approach. The starting point is to build on any existing systems to take advantage of investments already in place. The development of an EIS prototype for SOER would engender an adaptive and learning orientation to EIS development. It would promote consensus-building, while providing a practical and tangible focus allowing priority areas to be tackled first (Fedra, 1993). The basic components of such a prototype could be a meta-database referral system, the initial core database developed for a specific SOE product, a GIS capability, and a management capability for system development and quality control. Subsequent stages can extend the core database, provide additional services, and widen the network.

## 5 Summary

This chapter has shown that as a reporting program matures, a number of steps can be taken leading from a basic knowledge of what data are available to the development of a data management system. First, reporting agencies need to inventory and evaluate existing data and data sources. This will provide the basis for establishing a database network and a core database for reporting purposes. Initially, the core database will probably be statistical in nature, based on the comparative abundance of socioeconomic data. However, with a temporal dimension, it will support the reporting of trends. Subsequently, the next logical step is the development of a spatial database related to environmental quality, natural resources, and socioeconomic parameters. The development of such a GIS will permit the analysis of environment-socioeconomic linkages. This ability will be greatly enhanced through the adoption of an ecosystems spatial framework within the GIS to expand the capability to explore ecosystem processes related to, for example, anthropogenic pressures, material flows, resource impacts, and source-sink functions.

As the reporting experience grows, the availability of a core database and linkages to other data providers will provide the platform for a focus on data to support the development of environmental indicators as a critical reporting tool. In addition, data gaps will become evident, and the reporting agency can begin to influence the acquisition of new data through improved surveys, integrated monitoring, or remote sensing. The development of an information system provides the holistic framework for data development and its interactive access for reporting and environmental assessment.

This progression in data quality and availability parallels the advancement of reporting from description, to analysis and interpretation, to modelling and forecasting. In other words, reporting can advance from a single output--a static comprehensive report, to a network of geographically referenced data sets which support the development of a continuous family of products to meet a wide spectrum of user needs.

# V ENVIRONMENTAL INDICATORS

## 1 Introduction

We use indicators in our everyday life. Body temperature is used to indicate our general state of health, Gross Domestic Product (GDP) and unemployment rates are used to show the state of the economy. Socioeconomic indicators have been developed over the last 30 years, and, more importantly, are accepted as common currency. Attempts to develop environmental indicators are more recent and we have some way to go before they are as accepted and widely used as economic indicators. Various national, regional, and global initiatives are currently under way to develop and disseminate environmental indicators. The overarching objective of this work is to achieve information parity and balance among the major domains of sustainable development.

Environmental indicators represent a powerful tool for communicating synoptic information on the state of the environment to policy decision makers and the public. We need to improve databases related to priority environmental issues. But, it has often said that we have too much data and not enough information. Indicators represent a bridge between the wealth of detail and the need for interpreted information focusing on the significance of interactions and changes in the environment. They are an effective compromise between the user's need for quality, synoptic information and the statistician's desire for data accuracy and precision.

In this way, indicators serve two interrelated functions for the user. They reduce the number of measures required to give a representative and meaningful picture of what is happening in the environment. In addition, they simplify the communication process of transmitting information to the user. In meeting these functions, indicators have the potential to reduce the uncertainty level associated with decision making.

### Indicator Definition and Characteristics

Indicators are developed from statistical parameters, but have additional characteristics. They provide a simpler and more readily understood form of information compared to complex data and statistics. Moreover, indicators provide meaning beyond the attributes directly associated with them (Bakkes et al, 1994). There is no standard formula for the formation of indicators and, therefore, judgement is involved in their selection, development, and presentation. This judgement should provide indicators which optimize our limited knowledge about ecosystems, and provide relevant and appropriate information to users. In this way, indicators present a model of reality, but not reality itself.

Environmental indicators can be based on physical, chemical, or biological measures associated with environmental quality or natural resources. They summarize some aspect of the state of the environment, natural resource assets, and related human activities. To be useful in a sustainable development context, environmental indicators should relate environmental aspects to socioeconomic factors. A key characteristic of environmental indicators is that they track changes over time.

### Types of Indicators

Several types of indicators can be distinguished from the literature. In the context of SOER, it is important to stress the need for policy-relevant indicators based on solid scientific understanding. Such indicators can be classified as selected representative

measures, they can be in aggregated form as indices, they can be normative, or they can be retrospective or predictive (See Table 5-1). These overlapping types exhibit various advantages and disadvantages in the portrayal of meaningful information and each can play a useful role within a reporting program aimed at raising awareness and improving decision making (see Kuik and Verbruggen, 1991).

**TABLE 5-1**

**CHARACTERISTICS OF INDICATORS**

- Representative ⟷ Normative
- Disaggregated ⟷ Aggregated
- Retrospective ⟷ Predictive

Representative indicators use parameters to illustrate the direction of changes in the environment. For example, soil erosion, dissolved oxygen and sulphur dioxide can be used as indicators of land, water and, air quality respectively. Such simple indicators are usually easy to understand, can be useful in defining and ranking issues, and can inform us if environmental conditions are getting better or worse. The selection process means, however, that only one parameter is used as the indicator, while other important factors are neglected.

For policy performance assessment, it is desirable that the indicator be compared to a reference value, either a physical threshold or a normative policy target. A reference value could be used which represents a "natural" or historical benchmark, or an average value for a number of regions or economic sectors. Target levels or standards set by national policy or international convention can be used where available, but such references have not been established for all issue areas. The most significant question with respect to targets is their relationship to sustainability. Are the targets themselves adequate for the achievement of sustainable development? It should be remembered that although indicators are powerful guides for policy making, they cannot provide the total answer or demonstrate what policy represents the best option.

The usefulness of representative and normative indicators in SOER can be increased through the development of a profile or set of indicators for all aspects of an environmental issue, or for multiple issues. A well developed indicator profile can meet the needs of a variety of users, with custom selections possible to fit specific applications or client groups.

Others would argue, however, that such indicator profiles can become excessively large mitigating against the goal of reducing the information load to a manageable amount. One successful way of displaying a profile of complex environmental information in the form of an indicator is the use of an amoeba representation (See Box 5-1). However, many researchers advocate the aggregation of indicators into indices for priority environmental issues. This will provide synoptic information representing a wider selection of factors. With the issue of climate change, for example, an index of the four main greenhouse gases--carbon dioxide, methane, nitrous oxide and halocarbons--can be used. To achieve such aggregation a weighting scheme must be used based on the relationship between the

disparate indicators. In the case of climate change, the global warming potential of the individual gases can be determined and jointly expressed in carbon dioxide ($CO_2$) equivalents. However, indices have only been acceptably defined for a limited number of issue areas. The problem is the lack of sufficient scientific or empirical evidence to accurately assign weights. In addition, appropriate weighting can vary with time. Weighting may need to be adjusted because of new knowledge or changes in perception.

**BOX 5-1**

**THE AMOEBA AS AN INDICATOR**

An amoeba graphic can be used to represent an indicator profile of environmental parameters of a complex ecological system. It allows the display of dissagregated information in a form amenable to visual integration by the user. Such a presentation is one way of showing multi-dimensional data, and provides an alternative to index development as an approach for summarizing a lot of information related to numerous variables.

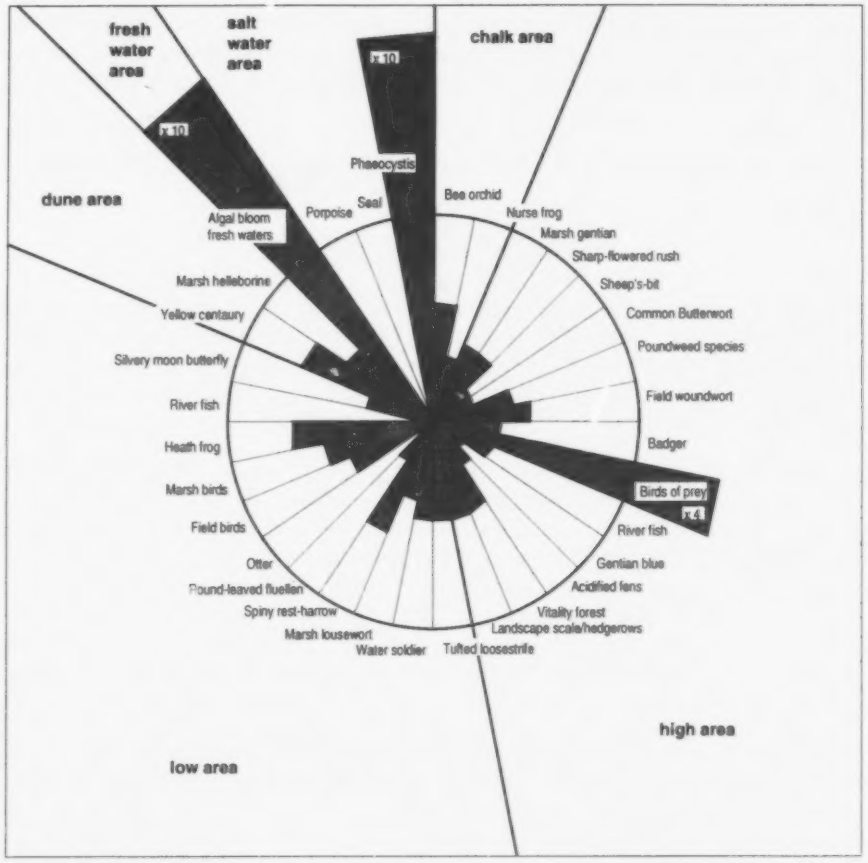
In the Netherlands, the amoeba presentation has been applied to develop environmental indicators for the aquatic ecosystem. The natural or relatively undisturbed ecosystem is used as a historical reference against which present conditions are compared. It is assumed that the undisturbed ecosystem, show by a circle in the amoeba diagram, represents a sustainable system. A number of target variables are selected and arranged in logical order around the circle. The current population levels of the target variables can then be plotted in relation to the circle to provide a quantitative measure of the difference between the reference value and present day conditions. It is also possible through modelling to assess changes in the target variables as a result of adopting various policy alternatives. In both cases, values greater than the reference will be plotted outside the circle, and those lower inside the circle. The points for the current situation and policy alternative of the target variables are then joined to give the amoeba shape to the diagram. Changes from the reference situation to present day conditions and policy objectives are clearly evident.

The number of target variables can be large, but obviously it is not feasible to compare all variables of a system, even if such information is available. It is possible to construct a number of amoeba graphics using different target variables for the same ecosystem. The shape of the amoeba will change, but the ultimate aim to show changes over time or to show the impact of various policy options should remain paramount. The following considerations are suggested as criteria for selecting appropriate target variables:

- availability of quantitative data;
- accessibility of the variable to easy and accurate measurement;
- susceptibility of the variable to human influence;
- indicative value of the variable for the condition of the system;
- representation of the entire system by the group of target variables; and
- political and social sensitivity of the variable.

The amoeba approach has potential for wide application as a useful form of indicator graphic. It can be used to show both predictive and retrospective changes at various scales and for complex ecological, social, and economic systems.

**BOX 5-1 (Cont.)**




Sources: Bakkes, et al., 1994; and Ten Brink, Ben. "The AMOEBA Approach as a Useful Tool for Establishing Sustainable Development" in Kuik and Verbruggen, 1991.

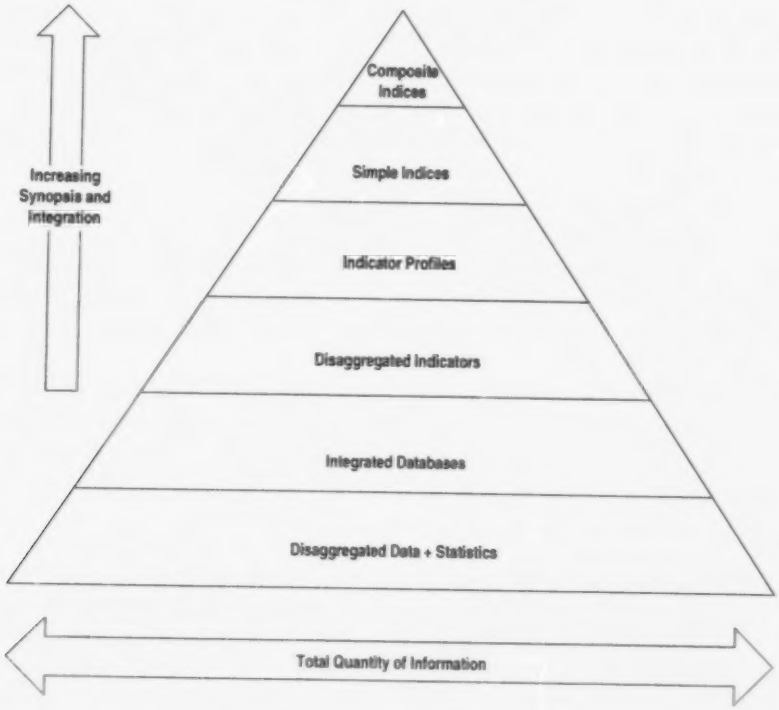
The number of environmental indicators represents a critical issue. The inherent purpose of indicators dictates that the number should be limited. The indicator initiatives outlined in Section 5 provide empirical experience on the size of indicator sets. Ideally, one would have an acceptable developed index for each policy goal, with each index composed of linked and more specific indicators for additional insight and analysis. However, complete index development for all issue areas represents a longer term goal, while reliance on a suite of selected indicators remains the most practical approach for most issues in the short term.

In the typical SOER program, retrospective indicators showing historical trends are usually developed. Such indicators are derived from scientifically reliable information and provide information about the effectiveness of existing policies. They are, however, of limited value in providing information about the future. Predictive indicators fulfil this role whether they are projections of historical trends or developed from models as alternative policy scenarios. Such indicators are useful as strategic planning tools for policy decision makers, but the greater degree of uncertainty associated with projections of future states of the environment must be openly recognized (see Chapter VI).

## Where do Environmental Indicators Fit in an SOER Program?

Environmental indicators should form an essential component of a SOER program. They can be particularly effective at reducing the information load by portraying socioeconomic pressures, environmental trends, and the results of societal responses quickly and continuously to busy readers and decision makers (Figure 5-1). Like socioeconomic indicators, their dissemination should be flexible. Environmental indicators can be released as they are developed or updated, indicator packages can be developed for specific circumstances or issue areas, or the complete array can be released periodically as a national set. However, the indicators themselves will continue to evolve. As knowledge and understanding of the state of the environment improves and priority issues and policy direction change, so must the set of indicators if it is to retain maximum utility to users.

**Figure 5-1**
**The Information Triangle**




Adapted from: Australia Department of the Environment, Sport and Territories, 1994

Environmental indicators do not in themselves provide the complete range of explanation, interpretation, and assessment that is possible in a comprehensive state of the environment report. Indicators can show that additional measures are needed, but the most appropriate measures must be determined from more detailed information. In addition, regional or sub-national variations may need to be determined by more discriminating interpretation. Thus, indicators and other forms of SOE products can complement each other to more fully meet the diverse needs of clients. In other words, the role of SOER is to analyze and interpret indicators to provide a greater understanding of environmental conditions and trends in a decision making context.

Making the case to include environmental indicators in a SOER program is easy. However, developing and obtaining acceptance of indicators is a much longer and complex process. The objective of the remainder of this section is to provide guidance on some common steps inherent in the indicator development process, and to outline a selection of indicator development initiatives.

## 2 Frameworks for Environmental Indicators

An analytical framework is useful in providing an organized and structured approach to indicator selection and development. A framework can help identify all environment-development interactions associated with ecosystems which influence the state of the environment. It can highlight system linkages and cause-effect relationships useful for policy decision makers and the public. Furthermore, a framework can help identify data gaps, and show contentious areas where appropriate indicators are not obvious and consultation would be most profitable.

There are several frameworks available which can be used to guide indicator selection and development. As discussed under the section on conceptual approaches, the focus could be on environmental media, socioeconomic sectors, an accounting framework, or ecological sustainability. A suitable framework for developing indicators at national or regional levels for SOER could involve three principle elements. First, at the general level, the framework would be guided by the three **societal goals** of environmental sustainable development listed in Chapter III: assuring ecosystem integrity; assuring human health and well-being; and assuring natural resource sustainability (Kerr, 1992). At a more specific level, the selection of indicators would be guided by **priority issues** of the region or country in question. Finally, the search for a set of indicators would be structured following the matrix provided by the **pressure-state-response** conceptual model (Hammond et al, 1995).

Of the three goals, ecosystem integrity is concerned with the decline in biodiversity through reduction of the ecosphere's gene and species pool, or through the loss of critical habitats or ecosystems. In addition, this goal encompasses the benefits derived from ecosystems such as pollution filtration, nutrient recycling, and scientific and aesthetic values.

The human health and well-being goal addresses environmental degradation and human health effects from pollution. It is primarily related to toxic compounds in the environment and the possible pathways into the human system. The primary pathways include air, radiation, water, and food. In addition, human well-being includes aesthetic and cultural attributes related, for example, to noise, odour, visual quality, and recreational opportunities.

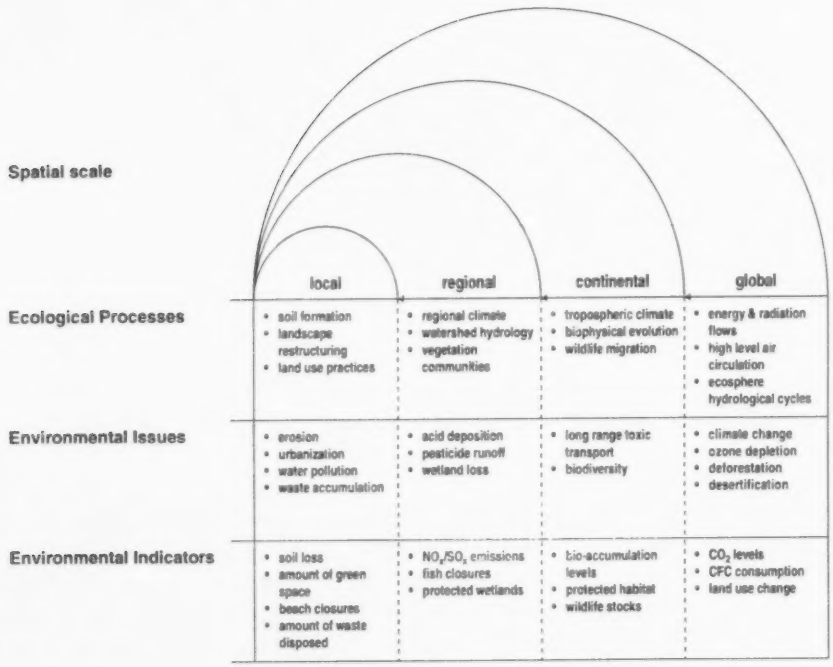
The goal of natural resource sustainability focuses on the economic benefit from the management and extraction of environmental resources. The primary concern is over resource depletion. This is inevitable with non-renewable resources, but the rate of depletion can be mitigated through new discoveries, more efficient use, or recycling. For renewable resources, depletion results if the sustained yield is exceeded or potential harvest area is reduced, through for example, land use change.

The definition of societal goals enables the delineation of issues which influence the achievement of these goals. Relevant issues for inclusion within an indicator framework have usually already been articulated through conferences, opinion polls, journals, and the media. There is an element of subjectivity and judgement in the selection of issues.

Therefore, it is appropriate to involve a wide spectrum of stakeholders to reach consensus on the list of issues for indicator development. In such a process, only issues of long-standing significance should be chosen. Nevertheless, the issues selected at any one time should not be regarded as totally fixed or final. Perceptions change and some flexibility is needed to incorporate new environmental issues of relevance to contemporary sustainable development decision making.

Priority issues will tend to be influenced by scale. Figure 5-2 shows the general relationship between possible indicators, environmental issues and ecological processes at various spatial scales. There is obviously overlap among the issues at different scales with higher level issues pervading all lower levels. National and regional indicators can only be developed recognizing this geographical context.

**Figure 5-2**
**Spatial Scales, Ecological Processes and Indicators**



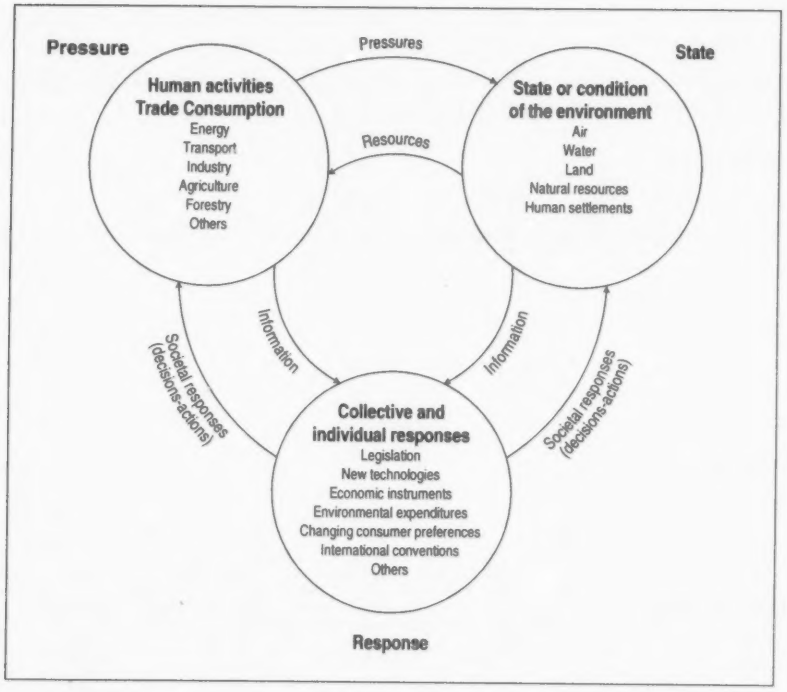

Adapted from: Langeweg, 1989 and Marshall et al., 1993

The most widely known discussion of global issues currently available is contained in Agenda 21 (United Nations Conference on Environment and Development, 1992). Examples of regional listings of issues pertaining to indicator development are available for Latin America, Asia, and the member countries of OECD (United Nations Environment Programme, 1994b; Winograd, 1995; and Organisation for Economic Co-operation and Development, 1993d).

The pressure-state-response model (see Figure 5-3) is based on the concept of causality, although it is not possible to isolate direct cause-effect relationships (see Chapter III). The presence and activities of human beings put pressure on the environment. Such pressures are often classified into underlying forces such as consumption, population growth or

resource harvesting. The pressures on the environment are often regarded from a policy perspective as the starting point for tackling environmental issues, and, from an indicator viewpoint, tend to be the most readily available being derived from socioeconomic databases.

**Figure 5-3**
**The Pressure-State-Response Model**




Adapted from: Australia Department of the Environment, Sport and Territories, 1994

Such pressures from society cause changes in the state or condition of the environment, our ultimate life support system. This state dimension is usually recognised as a change to environmental quality or to the stock of natural resources. From an environmental sustainability perspective, a sustainable "state" of the environment represents the ultimate goal. However, state indicators must be used in combination with pressure and response indicators to provide adequate information to policy decision makers and the public.

Changes in environmental conditions can lead to impacts which effect human health, the economy or ecosystems themselves. Such impacts have obvious significance for the public and policy decision makers. Examples would include rising unemployment due to a collapse in a fishery, increased food imports due to desertification, or increased expenditure on fertilizer to maintain agricultural yields.

The response component of the pressure-state-response model corresponds to societal action taken collectively or individually to mitigate or prevent negative environmental impacts, correct environmental damage, or conserve natural resources. Societal response indicators can measure regulatory action, environmental or research expenditures, public opinion and consumer preferences, changes in management strategies, and the provision of environmental information. Satisfactory indicators of societal response tend to be the

most difficult to develop and interpret. National ratification of international conventions, for example, is commonly used as a response indicator, but its meaning is elusive in terms of reflecting effective action and any chanage in the actual state of the environment.

The relationship between environmental issues and the pressure-state-response model are usually shown as a matrix. Such a tool is useful to help ensure that indicators are identified in a logical, systematic, and comprehensive way. In practice, however, such a simplified representation of the interactions in the environment must be used with caution and judgement. A matrix can induce simplified linear, reductionist thinking about ecosystems which behave as complex, dynamic and interlinked systems. Multiple, indirect and delayed causes and effects represent the norm within ecosystems. A response to one problem can often cause unexpected pressures elsewhere. For example, increased use of chemical sprays to control forest insect infestations can cause downstream water quality concerns elsewhere.

## 3 Selection Criteria

In conjunction with an indicator framework, the application of selection criteria is important in deciding which indicators are the most appropriate for SOED. Most discussions on environmental indicators refer to selection criteria (see, for example, Kuik and Verbruggen, 1991; Bakkes et al, 1994; Parker, 1991; and Organisation for Economic Co-operation and Development, 1993d). The emphasis, number of criteria, and terminology may vary somewhat from author to author, however, there is enough similarity and comparability that a common set of selection criteria can be proposed (Environment Canada, 1994b).

In general, selection criteria for environmental indicators are usually based on three overriding considerations: data reliability and analytical soundness; issue relevance; and usefulness to the user. A number of more specific selection criteria are associated with each of these broad considerations (see Table 5-2). The criteria reflect the essential requirements for credible information to meet user needs. If the information is not reliable, then improved decision making is not likely to be achieved and unsustainable policies and actions may result. On the other hand, if the information is not comprehensible it will not be used in the decision making process. The characteristics of each criteria are outlined below recognizing that there is some overlap between the categories. For example, geographic coverage should be appropriate for the issue, but is also relevant to the user.

**TABLE 5-2**

**COMMON INDICATOR SELECTION CRITERIA**

| Data Reliability | Issue Relevance | User Utility |
|---|---|---|
| Scientific Validity | Representative | Relevance |
| Data Availability | Geographic Coverage | Understandable |
| Data Adequacy | Responsive to Change | Reference Value |
| Cost-Effective | | Predictive |
| | | Potential for Comparison |

Data Reliability and Analytical Soundness

- **Scientific Validity**: the indicator should be technically and theoretically sound, consistent with scientific knowledge and understanding, and its significance defensible; and there should be wide consensus among credible experts that the indicator is valid.

- **Data Availability**: the data to support the indicator should be readily available, accessible, and timely; sufficient data should be available to show long term trends; the potential to acquire future data on a regular basis should be reasonably secure; and measurement over space and time should be consistent and comparable.

- **Data Adequacy**: the data should be of good quality, that is accurate, robust, able to be replicated, reliable statistically, based on standards and a fixed method of measurement, and insensitive to extreme values and number of observations; the data should be capable of being integrated, aggregated and disaggregated; metadata, including limitations, should be adequately documented; and the data should be useful for modelling and national accounting.

- **Cost-Effective**: the data supporting the indicator should not be difficult or expensive to obtain; should be within the capacities of national governments to realize; and the cost/benefit ratio should remain positive over time.

Issue Relevance

- **Representative**: the indicator should convey information broader than the parameter measured; and should provide a representative picture of environmental conditions, pressures on the environment, or societal responses.

- **Geographic Coverage**: the scope of the indicator should be appropriate for the region or country under study; ideally it should be applicable to different regions and scales; usually the indicator should be national in scope, applicable to issues of national and international significance, or apply to major ecosystems.

- **Responsive to Change**: the indicator should be sensitive to temporal changes in the environment and related human activities; the indicator set should be open-ended and flexible to accommodate new priority issues.

User Utility

- **Relevance**: the indicator should provide information to meet user needs; it should be meaningful in the context of environmental issues, and stated goals and objectives.

- **Understandable**: the indicator should be simple, unambiguous, and easy to interpret; the number of indicators should be limited in number; and the significance to the issue to which it is associated should be clear.

- **Reference Value**: the indicator should be associated with a threshold or target against which it can be compared, so that users are able to assess the significance of the values associated with it and track progress towards environmental goals.

- **Predictive**: the indicator should provide early warning of future environmental trends that have significance to human health, the economy and ecosystems; and it should be capable of supporting scenario development and forecasting.

- **Potential for Comparison**: the indicator should be presented so that there is a basis for international comparisons where this is warranted by the issue.

## 4 Application of the Selection Criteria

Of course, in practice any one indicator will not meet all criteria. Thus, the indicator selection process itself, although somewhat arbitrary, must be open and transparent. Although it is common in the literature to suggest selection criteria, the process of their application is rarely discussed. The application itself, however, raises important questions. Are the selection criteria of equal significance, or should they be weighted or ranked? At what stage of the indicator development process are the various criteria applied? Does the significance of the various criteria vary among different groups of stakeholders? A suggested general application of selection criteria is discussed below. It has been derived from Canadian experience in developing a national set of indicators (Environment Canada, 1994b). The process described is characterized by being iterative, informal, and consultative.

### Issue Selection

As discussed above, the initial stages in the indicator development process include the recognition of broad societal goals related to environmental sustainability, the adoption of a comprehensive and systematic framework, and the determination of environmental issues or sectoral issues which have significant impacts on the environment. The process of issue selection is usually at a more general level than the indicator selection process itself. It can be based on a dialogue between the public, policy makers, and the scientific community. Obviously, the issues should relate to the environmental sustainability goals and can be selected using a priority ranking scheme (see Chapter III).

### Research and Development

For each given issue area, background information from the literature and the results of consultation with scientific experts are assessed to provide an understanding of the causal links and relationships between the different elements of the pressure-state-response model. The reliability of the data in relation to the issue and the model is investigated. Although the full range of selection criteria may be applied, the primary concerns at this stage are: scientific validity, representation, responsiveness to change, data adequacy and availability. Geographic coverage, determined by the nature of the issue, is also important at this stage.

### Candidate Indicators

This stage is characterized by narrowing down the number of indicators or indexes to the first iteration of the most appropriate candidates. Such indicators can be proposed based on the full range of criteria. However, data adequacy and availability will tend to be evaluated initially as the essential criteria for acceptance of any indicator, with scientific validity, representation, and response to change considered as significant factors. At this stage, user criteria begin to play an important role in the selection process.

Draft Indicator Product

Following this initial scrutiny, a mock indicator product intended for users is sent out for external review by a broad range of selected stakeholders. Such a review would emphasize the user perspective and particularly apply such criteria as relevance, ease of understanding, presence of reference value, and potential for comparison. However, the scientific validity, degree of representation, and response to change remain important criteria.

Final Review

At this stage, the final review of the indicator product takes place prior to production. The evaluation of the indicators is based solely on the user criteria.

## 5 Selected Indicator Initiatives

Four indicator initiatives are described below to provide illustrative case studies. Their selection is based on three criteria: spatial scale; stage of development; and special characteristics. Examples were chosen to reflect global, regional, and national initiatives. Some examples are in an early stage of development, while others are producing and disseminating indicator information. All the examples reveal some noteworthy aspects which may be helpful to others wishing to develop indicators for SOER.

The work at the global level is represented by the catalytic activities under the UN Department of Policy Coordination and Sustainable Development. Two regional indicator initiatives for Latin America and the member countries of the Organisation for Economic Co-operation and Development are outlined. Finally, the indicator development program of Canada is presented. All of the examples employ the pressure-state-response model; other differences are highlighted in Table 5-3. A further interesting example of reporting using indicators comes from Norway and is outlined in Box 5-2.

The indicators most suited for national and regional situations will vary according to the priority issues, and goals and objectives for sustainable development. Table 5-4 presents commonly used indicators from existing projects. The experience from the selected indicator initiatives and Table 5-4 represent a starting point for discussions on appropriate environmental indicators for specific national and regional indicator initiatives.

UN Department for Policy Coordination and Sustainable Development (UNDPCSD)

Agenda 21 of UNCED repeatedly calls for the development of indicators of sustainable development. In Chapter 40, the Agenda encourages countries and international organizations to develop the concept of sustainable development indicators and, subsequently, identify such indicators. UNDPCSD is coordinating the follow-up to this recommendation with national governments, UN organizations, other intergovernmental organizations, and NGOs. Although this initiative is at an early stage of implementation, it is complementary to national and regional requirements for reporting on the state of the environment.

Currently, the ambitious effort is focusing on developing a balanced framework; identifying candidate indicators; and building consensus among countries, and international governmental and non-governmental institutions over the use of indicators as a management tool. A matrix is used to construct a framework based on the domains of

**TABLE 5-3**

**SELECTED INDICATOR INITIATIVES**

| Indicator Initiative | Purpose | Scope | Primary Reporting Units | Primary Organization of Indicators |
|---|---|---|---|---|
| UN DPCSD | SD Decision Making<br>SD Progress | Global | National<br>Global by Theme | i) Economic, Social, Environmental, Institutional<br>ii) Agenda 21 Issues<br>iii) Highly Aggregated Indices |
| Latin America | Development Process<br>Land Use/Natural Resource Management | Regional | National<br>Life Zone<br>Local | Pressure, State, Response, Predictive |
| OECD | Policy Performance<br>Environment-Economy Integration | Regional | National<br>OECD Groupings | 14 Issues of Environmental Quality & Natural Resources |
| Canada | SD Decision Making<br>Public Awareness | National | National | i) Environmental Goals for SD<br>ii) Environmental Issues |

Sources: United Nations Environment Programme and United Nations Department of Policy Coordination and Sustainable Development, 1995; Winograd, 1995; Organisation for Economic Co-operation and Development, 1993d; Kerr, 1992.

sustainable development; the issues addressed by Agenda 21 chapters, and the pressure-state-response model. The pressure indicators are called driving forces; deemed a more appropriate term for the four sustainable development domains--social, economic, institutional, and environmental. The framework is recognised as an organizational tool. Inevitably, there are overlaps between the domains and the issues. Although the framework itself implies causal relationships, it does not follow that the proposed indicators are in a direct cause-effect-response association.

The program encourages information exchange among all stakeholders. Methodology sheets will be used to guide the development of the indicators. Capacity building is recognized as an integral component to encourage national and regional participation. The menu of indicators will evolve based on pilot testing in selected countries and subsequent wider evaluation.

This early work has focused on selecting primarily disaggregated indicators where data is widely available. Consequently, a large menu is proposed from which countries will be able to select those they consider most appropriate for their national needs and conditions. In the future, the aim will be to reduce the number of indicators through aggregation.

## BOX 5-2

## ENVIRONMENTAL INDICATORS ON A PC

The Norwegian Ministry of the Environment and UNEP have collaborated to produce a state of the environment assessment of Norway based on a preliminary set of indicators. Other Norwegian agencies including the Mapping Agency, the National Institute of Public Health, the Directorate for Nature Management, the Central Bureau of Statistics, and the State Pollution Control Authority contributed to the project. The indicator information is contained on two diskettes accompanied by a user's guide. This simple PC application allows the user to navigate the indicators quickly depending on the subject area of interest and the depth of information required. This initial version has recently been updated and released on the Internet.

The program contains 25 environmental indicators classified into eight issue areas. The issues and indicators are presented using short texts, simple trend graphs, and thematic maps. An overview of each issue includes information on political objectives and actions. Data and data sources are included. Most of the indicators show changes over time. Information on international treaties and alternative problem-solving actions is also included. The program, through graphic and text editing, allows the user to export information for customized products.

### Issues and Indicators

**Global Warming**
- Emissions of Greenhouse Gases
- Extent of Ice in the Barents Sea

**Changes in the Ozone Layer**
- Emissions of Gases Affecting the Ozone Layer
- Changes in the Ozone Layer

**Contamination**
- Emissions of Selected Contaminants
- Atmospheric Deposition of Heavy Metal
- Pesticides in Birds of Prey
- Radioactivity in Animals
- Areas with Restrictions on Food Production

**Health Effects**
- Emissions of Pollutants
- Noise
- Ionising Radiation

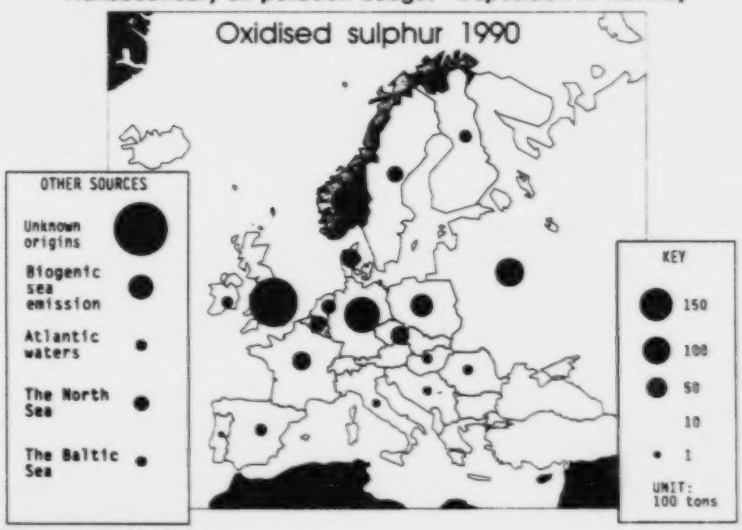
**Acid Rain**
- Emissions of SO2 and NOX
- Transboundary Air Pollution
- Forest Damage
- Damage to Freshwater Ecosystems

**Landscape Changes**
- Wilderness
- Damage to Lichen Vegetation

**Biodiversity Changes**
- Old Growth Forest
- Endangered Salmon Stocks
- Salmon Farming
- River Delta
- Changes in Marine Ecosystems

**Eutrophication**
- Freshwater Ecosystems
- Coastal Water

**Transboundary air pollution budget - Deposition in Norway**




Source: UNEP GRID-Arendal, May 1992.

**TABLE 5-4**

**FREQUENTLY SUGGESTED ENVIRONMENTAL INDICATORS**

| ISSUE | INDICATORS | | |
|---|---|---|---|
| | PRESSURE | STATE/CONDITION | RESPONSE |
| CLIMATE CHANGE | * $CO_2$ Emissions<br>* Greenhouse Gas Emissions | * Global Mean Temperature<br>* Ambient Levels of $CO_2$ or Greenhouse Gases | * Energy Intensity |
| OZONE DEPLETION | * Consumption of Ozone Depleting Chemicals | * Global Concentration of CFCs 11 & 12<br>* Atmospheric Concentration of Ozone Depleting Chemicals | * CFC Recovery Rates<br>* Contributions to Montreal Protocol |
| ACIDIFICATION | * $NO_x$ & $SO_x$ Emissions<br>* Index of Acidifying Substances | * Concentrations in Acid Precipitations<br>* Exceedance of Critical Loads in Water & Soil | * % of Fleet with Catalytic Converters<br>* Capacity of $SO_x$ & $NO_x$ Equipment for Stationary Sources<br>* Air Pollution Abatement Expenditures |
| WATER QUALITY/ EUTROPHICATION | * N & P Emissions<br>* Wastewater Discharges<br>* Livestock Density | * BOD, DO, N & P Levels in Ambient Water | * Population served by Treated Water Supply<br>* User Charges for Wastewater Treatment |
| TOXIC CONTAMINATION | * Consumption of Pesticides<br>* Generation of Hazardous Waste | * Concentration of Heavy Metals in Biophysical Environment<br>* Area of Land Contaminated | * Market Share of Unleaded Petrol<br>* Sites Cleaned up as % of Total |
| WASTE | * Waste Generation by Sector | * Number/Area of Waste Disposal Sites<br>* Soil/Groundwater Quality | * Waste Reduction of Recycling<br>* Waste Management Expenditures<br>* Waste Disposal Charges |
| URBAN ENVIRONMENTAL QUALITY | * Air Emissions<br>* Traffic Density<br>* Rural-Urban Migration | * Urban Air Quality<br>* Ground Level Ozone Concentrations | * Pollution Abatement Expenditures<br>* Amount of Green Space |

| | | | |
|---|---|---|---|
| MARINE PROTECTION | * Catches of Marine Species<br>* Coastal Discharges<br>* Marine Spills | * Biocontamination Levels<br>* Stock Size | * Stock Quotas<br>* Stock Monitoring Expenditures<br>* Shellfish Area Closures |
| BIODIVERSITY | * Habitat Change or Land Conversion | * Threatened & Extinct Species as % of Total<br>* Ratio of Exotic to Endemic Species<br>* Stock of Key Species | * % of Total Area Protected |
| DEFORESTATION | * Harvest Related to Sustained Yield<br>* Forest Land Conversion | * Forest Area or Volume | * % of Harvest Area Regenerated<br>* % of Forest Area Protected |
| LAND DEGRADATION | * Arable Land per Capita<br>* Livestock Density<br>* Fertilizer & Pesticide Use | * Area Affected by Soil Erosion, Desertification, Salinization, Waterlogging<br>* Extent of Wetlands | * Rehabilitated Area<br>* Reclamation Expenses |
| WATER RESOURCES | * Water Consumption per Capita<br>* Intensity of Use | * Water Shortages<br>* Groundwater Reserves | * Water Price & User Charges |
| ENERGY USE | * Energy Consumption per Capita | * Energy Reserves | * Energy Intensity<br>* Renewable Compared to Non-Renewable Use |

Initially, aggregation would be within indicator cells, for example greenhouse gas emissions would be combined into a single driving force indicator. Subsequently, further aggregation would focus on the development of a composite pollution release index.

This aggregation task is being pursued at the same time as the development of the menu through the activity of the Scientific Committee on Problems of the Environment (SCOPE, 1995). The conceptual framework for environmental indicators adapted by SCOPE focuses on the fundamental physical principles of human-environment interactions (Hammond et al, 1995). Four components are suggested for such interactions:

- the environment acts as a **source** for human economic activity;
- the environment acts as a **sink** to receive pollution and waste from human activity;
- the earth's ecosystems provide a number of essential **life support** services; and
- the reduction in the environment's ability to provide essential services produces an **impact** on human welfare.

These components suggest four highly aggregated indices: **net resource depletion; composite pollution; ecosystem risk; and human welfare impact.** Under these four

categories, SCOPE has proposed about 25 aggregated indicators which are seen as equivalent to the pressure side of the pressure-state-response framework. It is suggested that the indices incorporate linkages among economic, environmental, and social factors. Thus, the indices are proposed as the major environmental measures of sustainable development.

Following the consensus building stage, it is proposed that development work on the accepted menu of indicators be shared among the specialist agencies for completion by 1996. Subsequently, national governments would be invited to complete their voluntary reporting to the DPCSD using the framework and the suggested indicators for the issues applicable to that country to the extent possible.

Environmental Indicators for Latin American and the Caribbean

A baseline of environmental indicators for Latin America and the Caribbean has recently been completed by the Ecological Systems Analysis Group of Argentina, in cooperation with the Inter-American Institute for Cooperation on Agriculture, the Organization of American States, and the World Resources Institute (Winograd, 1995). The objectives of the study were to prepare a set of indicators for use in the design, monitoring, and evaluation of environmental policies as they relate to development, land use, and natural resources management. For Latin America, land use is recognised as the key issue allowing the development of linkages to the ecological, social, and economic factors of the region. Consequently, pollution and emission indicators are relatively scarce in this set.

The pressure-state-response model is used as the major organizational structure for the presentation and discussion of the environmental indicators. In addition, a fourth group of prospective indicators is included to show the consequences of alternative strategies and to help establish sustainability targets at national and regional levels. In total, 44 pressure, 47 state, 5 response, and 12 prospective indicators have been developed. The indicators are grouped by variables rather than by environmental issue across the pressure-state-response model. Environmental issues are used in the indicator selection process, especially those related to land use. However, unlike other indicator projects, issues are not explicitly used in the presentation structure. The variables describe the environmental and land use situation in the context of sustainability. The variables, in turn, are composed of a number of elements and descriptors which help to define the indicators. The primary time period for the analysis is 1970 to 2030, although data is used from the 1960s. The indicators are primarily presented in tables by countries and life zones. Where multi-year trend information is available simple bar graphs are used. A short analytical text and technical notes on the data accompany each variable.

There are two unique aspects of this Latin American indicator initiative: the use of life zones and the presentation of prospective indicators. In Winograd's study, countries are used as one structuring spatial element. However, recognizing that not all development decisions are uniformly applicable at national levels, other spatial scales are proposed for analyzing the development process and its impact on ecosystems, environmental quality and natural resources. Eighteen life zones, with common ecological and productive characteristics, are used as the second major spatial breakdown for the presentation of the indicators for the whole of Latin America and the Caribbean. The life zones, reflecting environmental and human factors, are aggregated according to vegetation and land use, with topography, hydrology, and climate used to define the zones. In addition, some indicators are presented for more localized basins or ecosystems.

The presentation of prospective indicators warrants special attention. In this section of the report, the indicators show land use changes by life zones for the period 1980 to 2030 using two options: a reference scenario and a sustainable scenario. The reference scenario represents a continuance of existing trends, while the sustainability option emphasizes rehabilitation and restoration of deteriorated areas; a priority for integrated and productive rural systems; and the integration of traditional and modern technologies. The analysis based on the indicators shows that sustainable development with respect to land use is ecologically, technologically, and economically feasible provided appropriate policies are in place.

This study represents progress in determining regional indicators focused on natural resources. The work continues at the Centro Internacional de Agricultura Tropical (CIAT) as a joint project with UNEP. The application of indicators to life zones and the presentation of prospective indicators are important contributions to the indicator development field. Many of the indicators used will have relevance to other resource-based regions and to the ecosphere as a whole.

Organisation for Economic Co-operation and Development (OECD)

OECD's current interest in indicators stems from its Ministerial Council meeting of 1989, when renewed emphasis was placed on integrating environmental and economic decision making as a means of contributing to sustainable development. Subsequently in 1991, the Council instructed its Environmental Policy Committee to "further develop core sets of reliable, readable, measurable and policy-relevant environmental indicators" (OECD, 1994). The OECD Group on the State of the Environment, in response to this directive, recognises four purposes for the development of indicators:

- to measure **environmental performance**;
- to integrate environmental concerns into **sectoral policies**; and
- to support the development of **environmental accounts**.
- to report on the **state of the environment**.

Environmental performance indicators contribute to assessments of member country's policy performance by comparing achievements and progress with national objectives and international commitments. The context for the reviews is determined by the individual country's environmental, physical, human, and economic situation. Sectoral indicators emphasize the linkage between the environment and the economy. To date, OECD has developed such indicators for four sectors: energy, transport, forestry, and agriculture (See, for example, OECD, 1993a). Work on environmental accounting contributes to environment-economy integration more generally through the development of satellite and natural resource accounts. OECD has published information on pollution abatement and control expenditures, and completed stock and flow resource accounts for forestry and water (See OECD, 1993c and 1993d). In 1991, a preliminary set of environmental indicators was published to support the reporting function of OECD (Organisation for Economic Co-operation and Development, 1991). The remainder of this section focuses on the development of a core set of environmental indicators for policy performance assessment.

To arrive at its core set, the OECD Group on the State of the Environment Group held a series of workshops in 1993 (See Box 5-3). As a result of the workshops, OECD

subsequently developed for presentation the core set of indicators where measures were available for a quorum of its members (Organisation for Economic Co-operation and Development, 1994). The indicators are shown using a combination of line and bar graphs, tables, and text. The average value for OECD countries or other country groupings are used as simple reference values. Where trends are shown, the common period of analysis is 1980 to the early years of the 1990s.

This effort represents a leading achievement to develop indicators at the international level. However, it is recognized that the work to develop a harmonized set which is most pertinent to users is far from complete. The current core set of 72 indicators represents only a stepping stone; it is not definitive or exhaustive, neither are all the indicators supported by adequate data at this time. In its 1994 publication, OECD is only able to present 31 indicators of the core set; and 57%, 29%, and 7% of the first-choice indicators for pressure, condition, and response respectively. The percentage of the first-choice pressure indicators drops to 24%, if the general category of socio-economic indicators are not included.

The OECD indicator initiative illustrates the discrepancy between desirable indicators and the ones we are currently able to supply. Within countries and at the international level, it must be remembered that the collection of integrated environmental data within a sustainable development context has only a short history. It is the norm for environmental data that definitions and measurement methods differ from jurisdiction to jurisdiction, making comparisons between countries hazardous. The detailed and extensive technical annex of the OECD's indicator publication illustrates this point by providing information on the anomalies of nations data compared to the suggested OECD standard.

At OECD the work will continue to strengthen, harmonize, and improve the core set of indicators. The objective will be to improve the data quality and availability at the national level through the development of technical specifications for consistent measurement. Over the longer term, research will be pursued to allow the presentation of more first-choice indicators. The potential application of OECD's core set goes well beyond the immediate use of performance reviews. Such indicators contribute to the broader objectives of SOER and provide the environmental building block for measuring progress towards sustainable development.

National Indicator Development in Canada

Similar to several countries, Canada has pursued the development of environmental indicators since the early 1970s. An early attempt in 1972, for example, proposed the development of a single index of environmental quality based on indicators within four environmental quality indices for air, water, land, and a miscellaneous category (Inhaber, 1972). However, this proposal, due to questions related to methodology, data, and utility, was never fully developed or released on a regular basis.

Canada's current work on environmental indicators commenced in 1988 within the national state of the environment reporting organization. It was stimulated by the heightened international interest in indicators as a tool to measure progress which surfaced from about 1989 onwards. National impetus to develop a set of indicators was strongly reinforced with the release of Canada's environmental action plan, the Green Plan, in 1990. Currently, progress on the national set is aided by the complementary indicator activities of several governmental and non-governmental agencies in Canada. Statistics Canada, for example, is completing oil and gas, and forest studies for natural resource accounting. Forestry Canada has developed an initial set of forestry performance indicators.

**BOX 5-3**

**DEVELOPING A CORE SET OF INDICATORS**

In 1993, OECD held a series of workshops to develop environmental indicators for use in country environmental performance reviews. Such reviews are conducted periodically to assist member countries to move towards sustainable development by improving their individual and collective performance in environmental management. The reviews focus on performance with respect to environmental quality, national objectives, and international commitments. Environmental indicators are recognized as one of the tools to assist the process of performance assessment. Other quantitative and qualitative supplementary information will be required to ensure correct interpretation and provide the overall context of the ecological, geographical, social, economic, and structural character of countries.

**Objectives**

The principle objectives of the workshops were to:

- contribute to the harmonization of environmental indicator initiatives being conducted by individual member countries;
- provide guidance on the use of environmental indicators in the evaluation of environmental performance; and
- encourage the development of a core set of selected and/or aggregated indicators for international use.

**The Workshops**

The workshops consolidated indicator terminology, agreed on indicator selection criteria, reached consensus on fourteen priority issues, accepted the pressure-state-response framework, deliberated over the composition of the core indicator set, and accepted some principles for the application of indicators in environmental performance reviews. In addition, the workshops considered disaggregating the indicators to the sectoral level. This would permit the analysis of environmental pressure or societal response by socio-economic sector.

The priority issues covered environmental quality, natural resources, and a general category of indicators. In total 72 indicators were recommended for the core set: 30 as pressure indicators; 16 as indicators of environmental conditions; and 26 as indicators of societal response. The indicators selected represent three classes: those that were considered as the best or first-choice; proxy measures to provide representation where the first-choice indicators are not currently available; and supplementary indicators to provide a broader perspective on some issues. All the indicators were rated according to their availability over the short, medium, and longer terms. Short term indicators were those considered currently available for the majority of member countries; while long term ones, although seen as better indicators, require new data for many countries and significant additional development work.

The workshops demonstrated the collaboration and cooperation that can be achieved at the international level in the development of environmental indicators. The indicators are designed for national environmental performance assessment, but provide a building block for a broader set of sustainable development indicators. The available indicators are currently being used as a performance assessment tool, while efforts continue to improve and consolidate the core set.

Source: OECD, 1993d

The objective in Canada is to regularly report on a set of scientifically credible environmental indicators which are relevant and understandable to decision makers and the public. For this reason, the Canadian approach places considerable emphasis on consultation with users and data holders. The aim of the national set is to provide a synoptic picture of the state of the environment and show trends related to the environmental goals of sustainable development.

In 1991, Canada released a preliminary national set of environmental indicators (Environment Canada, 1991). The report presented a total of 43 indicators organised under 18 issue areas. The indicators were developed from readily available data primarily from national survey and monitoring programs. The presentation by issue of national significance maximized the use of simple graphics supplemented by explanatory text. Target values and standards were included where these had been established. The main purpose of this preliminary set was to provide a basis for discussion and a benchmark from which to develop environmental indicators for regular release.

Regular reporting on a national set of environmental indicators commenced in 1992 through the release of indicator bulletins on specific issues. With this disaggregation to the issue level, the indicator information is released in a continuous and timely manner. To date, nine issues have been developed as indicator bulletins: climate change, stratospheric ozone, toxic contaminants, urban air quality, urban water, marine resources, timber harvesting, energy consumption, and passenger transport. The bulletins report on indicators of pressure or human activity, environmental conditions or resource stock, effects, and societal response where trend data of sufficient quality is available. Linkages between the environmental indicator and socio-economic factors are frequently supplied. In the climate change bulletin, for example, policy relevance information is provided by plotting GDP trends against carbon dioxide change. In the marine resources bulletin the commercial catch trend is shown together with the landed catch value. In addition, the program uses implication sheets to help targetted decision makers appreciate the linkage between policies, regulation and management, public opinion, human health, and environmental trends.

With the initial release of an indicator bulletin, a commitment is made to regularly update the information, this is usually completed on an annual basis, but depends on the availability of new data. In addition, the bulletins are released accompanied with a technical supplement which provide the data, metadata, and methodology behind each indicator. The bulletins and technical supplements are issued as print products and customized for electronic access via the Internet.

## 6 Summary

This chapter has focused on the background and development process associated with environmental indicators: an effective reporting tool for raising public awareness and facilitating decision making. Brief outlines of selected contemporary indicator initiatives provide examples of putting theory into practice. From the material presented, it is possible to suggest a step-by-step process to guide the development of a set of indicators for SOER. This is summarized in Table 5-5.

Although important progress has been made using existing data, considerable development work and consultation remains before environmental indicators are accepted as common currency. A longer term, persistent, and cooperative commitment will be required to develop the first-choice indicators most suitable for decision makers. It is relatively easy

to formulate issue and indicator lists, but more difficult and time consuming to develop the indicators for publication and dissemination.

The focus of current indicator achievements is concentrated on the use of disaggregated indicators in the form of profiles or core sets. At the same time, research is being pursued to develop more aggregated indices. In the future, we are likely see the blended use of both aggregated and disaggregated indicators. The indices will provide the overall picture on sustainable development progress, while their disaggregated cousins provide information on more specific issues to guide future policy direction.

**TABLE 5-5**

**GENERIC INDICATOR DEVELOPMENT PROCESS**

Step 1 **Select Framework**

↓

Step 2 **Select and Define Approach**
(e.g. societal goals, issues, criteria)

↓

Step 3 **Propose Initial Core Set of Indicators**

↓

Step 4 **Evaluate Indicators and Define Core Set**

↓

Step 5 **Apply Data to Develop Indicators**

↓

Step 6 **Disseminate Available Indicators**

↓

Step 7 **Continue Development of Superior Indicators**

# VI THE FUTURE STATE OF THE ENVIRONMENT

## 1 Introduction

SOER has tended to examine conditions and trends in the environment retrospectively. The past and present state of the environment are assessed to determine if progress is being made towards sustainable development. SOER has been less successful at adopting a more proactive approach to interpret the future state of the environment. Indeed, it has been suggested that this deficiency limits the usefulness of SOER to policy decision making (Maas, 1991). By raising awareness of future prospects, reporting can better set the stage for further environmental policy development. In such prospective analysis, SOER remains a tool to provide sound information on potential future environmental conditions in order that decision makers can respond with effective policies and strategies.

A better balance between diagnosis and prognosis is within the scope of SOER as defined in the introductory chapter. In fact, the development of a futures perspective in SOER is only feasible based on a solid foundation gained from the interpretation and assessment of past and current conditions and trends. It is clear that a prospective stance is consistent with sustainable development, especially its long-term emphasis and focus on future generations.

Forecasting within an SOER program increases its comprehensiveness and integrative capacity. From an environmental sustainability perspective it does not seem logical to restrict the analysis to past and present conditions. Defining the gap between existing environmental conditions and those that are sustainable within the scope of SOER is important for both scientific and policy reasons. Many environmental problems do not become apparent immediately or over the short term because of the buffering capacity of ecosystems. Similarly, it usually takes persistent societal action before an acceptable state of environment is realized. This characteristic lag effect for both issues and responses means that a credible long-term view of the future, based on the best scientific knowledge, is critical for preventative decision making.

Forecasting is inherently difficult because of the significant uncertainties involved. The future cannot be predicted with precision due to our limited knowledge of ecosystem behaviour, including socioeconomic changes. No one knows for sure what future population levels, energy prices, or technological breakthroughs will occur or the effects of these socioeconomic changes on environmental issues such as climate change or acidification. No one can accurately predict future resource demands and consumer consumption levels and their effects on biodiversity. Furthermore, it is extremely hard to predict the consequences of existing policy. The degree of implementation and compliance may be divergent from anticipated levels due to a host of unanticipated reasons.

Nevertheless, the profound potential impacts of possible future change oblige us to heed the signs with appropriate information as a foundation for awareness raising and anticipatory response (see Box 6-1). We can use the knowledge we do have to create long-term scenarios of probable future socioeconomic and environmental conditions. Consistent with SOER principles, these scenarios should be based on the best science and information, probability theory, and realistic interpretation, not on conjecture or divine prophesy. This approach is compatible with the application of the precautionary principle under which a problem should not be neglected because of uncertainty. Instead, where the probability and risk of adverse environmental consequences are high, the scientific

**BOX 6-1**

**CHANGE AND THE FUTURE STATE OF THE ENVIRONMENT**

**The Worldwatch Institute**

The Worldwatch Institute is a non-profit, research organization which provides insightful reporting on existing and emerging global problems, including those that have potential to affect the future state of the environment. The organization publishes on an annual basis *State of the World* and *Vital Signs* reports. A recent article in the organization's magazine *World Watch* discussed the profound and rapid changes that are occurring in China. The article demonstrates the value and pertinence of studying potential futures. The linkages between population, economic development, and life style changes; and the potential impacts on the state of the environment are examined using simple, but compelling scenarios.

**China 1990-2030**

Four socioeconomic trends are converging in China in the 1990s: the population is growing by 14 million people per year; annual economic growth is above 10%; an increase in disposable income is resulting in the change from a rice to a meat diet; and the country's capacity to produce food is declining. Such transformations from an agricultural to an industrial society are compared to similar developments in neighbouring countries such as Japan and South Korea. However, in the case of China the magnitude of the changes will have enormous repercussions for trade, food supply, and environmental quality, both within the country and globally.

The core of the *World Watch* article focuses on China's food requirements in the early twentieth century and its ability to feed itself. From this starting point, the interactions between food production, industrial development, and the environment are discussed. The decline of productive agricultural land has been 1% per year between 1990 and 1994. Land degradation will probably increase, while water quality will deteriorate. Water shortages are already common in China, and increased demand will further deplete aquifers. Air pollution and acidification are intensifying and will adversely affect China's natural resources as well as contribute to global environmental problems.

If these emerging trends in China continue, the country's recent grain deficit will deepen and become permanent. The article suggests three scenarios for China's grain production. With current population and economic growth but no increase in meat consumption, a grain deficit in 2030 of 263 million tons is forecast. This amount exceeds the total 1993 world export of grain of 200 million tons. With modest increases in per capita grain consumption, this 2030 deficit rises to 305 million tons. Finally, if grain consumption were to rise to 400 kilograms per person--the current level in Taiwan and only half the level in the United States--the annual deficit would be 378 million tons in 2030. Trying to meet this increased demand would put pressure on the environments of potential exporting countries such as Argentina, the United States, Canada, and Australia. Environmental changes could result, for example through the use of marginal lands, increased soil erosion and water depletion, and increased application of nutrients and pesticides . However, it is concluded that meeting this magnitude of grain deficit is beyond the collective carrying capacity of all exporting countries.

**The Challenge**

This situation represents a major sustainable development challenge to the global community. Fundamental structural changes will be required if this challenge is to be met. The further development of scenarios incorporating some of the necessary structural shifts would provide insight into the range and magnitude of the measures required to stay within the limits of the earth's natural systems.

Source: Brown, 1994.

analysis and reporting of future environmental states becomes imperative for sound, anticipatory decision making.

In this Chapter we look at some of the elements required for forecasting the future state of the environment. This is illustrated by using examples from SOE reporting initiatives which take a futures perspective. These range from basic and synoptic efforts to those where the total reporting direction is orientated towards the future. The examples chosen are intended to give an illustration of the range in depth and intensity of forecasting that can be accomplished within SOER. For Chapter context, it is important to recall the discussions on other aspects of reporting covered elsewhere in this report. Conceptual frameworks, databases and indicators, information systems capability, and institutional collaboration all play a role in the successful assessment of future environmental conditions and trends.

## 2 The Dimensions of Future State of the Environment Reporting

The key to forecasting the future state of the environment is the formation of realistic scenarios which describe the progression of events leading from a baseline, usually the current state, to a future situation. Scenarios in the context of SOER are based on the likely sequence of socioeconomic pressures taking into account a prevailing mode of societal response. These situations are then used to predict future environmental consequences through the use of qualitative and quantitative approaches. To accomplish this, information on the environmental consequences of various measures that are in place or could be implemented is required. For this, it is useful to distinguish between exogenous influences over which one has little control, and internal factors which can be more readily adjusted through policy change. Finally, scenario development usually implies the use of reference values and criteria to enable comparison between actual and desirable environmental conditions. Such values can be national or international targets; levels deemed to be sustainable on the basis of existing science such as no effect or critical load amounts; or a selected historical level.

In some examples of forecasting, only one scenario is considered, usually based on a continuation of current trends. The results can simply be summarized in a table in an SOE report which indicates if environmental conditions will be getting better or worse. This is illustrated in *The State of the Finnish Environment* report (see Table 6-1). On the other hand, the forecasting analysis can be extensive to form the basis of a comprehensive SOE product.

However, it is advisable to develop more than one scenario to provide a range of interpretation of the likely future state of the environment, because of the uncertainties inherent in forecasting. The number of scenarios should remain low for practical reasons. The consideration of more than one scenario takes proportionally more time because of the need for extra discussion and debate (Ton Rutjens, personal communication). In general, three types of scenario related both to broad socioeconomic trends and potential policy strategies can be distinguished (United Nations Environment Program, 1995):

- **Business as Usual:** under such a scenario, the conventional development of the tendencies implicit during the baseline period are assumed to continue. Under such a forecast, recognition of the future impact of existing policies and societal changes may mean that existing environmental trends are adjusted, and not simply an extrapolation from current conditions.

## TABLE 6-1

## THE FUTURE OF THE FINNISH ENVIRONMENT

| Variable | 1945-1990 | 1990-2040 | Criteria | Trends and Comments |
|---|---|---|---|---|
| Biodiversity | - | -- | No. of endangered species | Threats not dwindling |
| Climate Change | = | - | Temperature and precipitation | Development unclear |
| Ozone Depletion | - | -- | Ozone in stratosphere | Trend continuing despite amended Montreal protocol |
| Disturbance of natural environment | - | -- | Movement | Protected areas do not compensate for increased disturbance |
| Acidification | - | - | Reduction of buffer capacity of soil, and surface and groundwater | Acid precipitation declining, but not enough to take load below critical level |
| Eutrophication | - | -- | Basic production of plankton | Algae blooms more common resulting in oxygen depletion |
| Toxic Metals | - | - | Levels in animals and plants | Not including lead, whose levels are declining |
| Organic Toxins | - | + | Levels in animals and plants | The huge range of such toxins is poorly known and could contain surprises |
| Waste | - | = | Volume of wastes | Boom-recession cycle affects trends more than policies |
| Noise | - | - | No. of people affected | Traffic noise increasing |
| Baltic Sea | - | -- | Change in biodiversity | Eutrophication discharges continuing; increasing coastal disturbance |
| Inland Waters | - | - | Change in biodiversity | Worst areas are improving; but eutrophication and disturbance levels are generally increasing |
| Forests | - | -- | Change in biodiversity | Fragmentation and disturbance is increasing; old forests are becoming scarce; acidification and climate change are weakening factors |
| Bogs and Wetlands | - | - | Undrained area | Drainage declining, but not ended completely; building will continue on coastlines and lakes |
| Health | + | = | Life expectancy | Outdoor environment has less impact than lifestyles and consumption habits |

Trend: + Improving; = No Change; - Deteriorating; -- Increasing Deterioration.
Forecast based on the continuation of current trends and the implementation of existing remedial measures.

Adapted from: Table 48; Wahlström, Hallanaro and Reinikainen, 1993.

- **Moving Towards Sustainability:** here, a contrasting scenario is proposed to take account of uncertainties and to recognize the inadequacies of current circumstances from a sustainability viewpoint. Such scenarios may, for example, propose higher energy prices, land rehabilitation, and the application of best available technology.

- **Achieving Sustainability:** the starting point for this type of scenario is the development of a sustainable future state and determining the feasibility of its achievement. Such scenarios are difficult to define due to limited scientific knowledge of ecosystems and different societal value systems. In practise, however, they can be achieved through expert or community consensus. The scenarios could well involve trade offs between socioeconomic and environmental factors; and incorporate structural and behavioral changes in addition to correcting existing pollution and natural resource problems. In this type of scenario, the environmental conditions and trends can be determined by backcasting from the sustainable future to the baseline period.

In scenario development for SOER, a long-term view is required. The actual period for analysis tends to be somewhat arbitrarily set and can vary from 10 to 100 years. The typical period selected is usually 25 to 40 years, corresponding to the approximate timeframe of one generation. Some flexibility is required, however, depending on the environmental issue under discussion. Forecasting timeframes for such global issues as climate change and stratospheric ozone depletion are typically 50 to 100 years.

The continuity of state of the environment forecasting is a significant consideration. It is advisable to update the scenarios on a regular basis to build on experience; take account of improved environmental data and knowledge, and the consequences of unexpected socioeconomic changes. The appropriate cycle for adjusted forecasts could coincide, for example, with the typical three to five year interval of comprehensive national or regional assessments.

Two approaches for forecasting the future state of the environment are possible: **qualitative** and **quantitative**. Qualitative assessments can be useful where databases and models are not available or too poorly developed to permit a quantitative approach. Here, the direction and general magnitude of current status and trends can be extended into the future through the use of expert or community opinion and consensus. This has been used, for example, in the Southern Africa State of the Environment Report where a cross section of regional experts were consulted over the development of two future scenarios (see Box 6-2).

Where socioeconomic and environmental data on trends exists in sufficient quantity and quality, integrated or linked models can be used to provide a quantitative assessment of future conditions. Models reflect our understanding of how systems function and interrelate, and, therefore, must inherently be simplifications of reality. Nevertheless, they can formalize the synthesis of data from many disciplines, show linkages and feedbacks among socioeconomic and environmental sub-systems, and have predictive capabilities (Alcamo, 1994). Integrated modelling covering the range of interactions pertinent to reporting on the state of the environment is a relatively young field. Nevertheless, with calibration to a known baseline period, it can be an effective tool for the reduction of scientific uncertainty concerning future environmental conditions.

The following section discusses in more detail two case studies of quantitative scenario development in the Netherlands and Latin America related to the state of the environment. It is complemented by Box 6-3 which briefly examines the emerging focus on state of the environment prognosis at the global level.

**BOX 6-2**

**SCENARIO DEVELOPMENT IN SOUTHERN AFRICA**

**The Context**

The 1994 State of the Environment report for Southern Africa includes a final chapter entitled *Trends and Scenarios*. The approach used to prepare this section of the report depended upon expert consensus to arrive at a qualitative and exploratory analysis of the future state of the environment in 2020. A workshop of regional and international experts was used to discuss two possible scenarios for the Southern African future. The first scenario describes what will likely happen if current trends more or less continue. The second scenario is closer to a vision of the way the environment could be if realistic measures are undertaken.

**Reaching Consensus**

The workshop objective was to provide an integrated, holistic approach to scenario building. It was attended primarily by regional experts, although a few participants came from other African nations and elsewhere. The group included people who were policy makers, others came from the private sector, interest groups, the media, academia, and the traditional sector. Various disciplines were represented including ecology, hydrology, wildlife management, agriculture, forestry, chemistry, geography, economics, demographics, education, and communications. The draft chapters of the SOE report were provided to the participants to give them a common baseline on current environmental conditions and trends.

The first task of the workshop group was the determination of the most important variables affecting the regional environment to the year 2020. Developments largely beyond the control of the region itself were given less emphasis. These driving forces were grouped into socio-political, economic, and human resource categories for discussion in small group sessions. Poverty was regarded as a universal factor cross cutting all variables.

The impact of these variables on environmental quality, productivity, and biodiversity was estimated using the four environmental components of land use, fresh water, air, and marine. The land use component was sub-divided into agriculture, grazing, forests and woodlands, human settlements, and protected areas. Fresh water included both quality and availability. The impacts were judged to be positive or negative, and, following lively debate, a general set of directions for the "business as usual" scenario emerged.

The most influential variables were further discussed with respect to the desirable future scenario. Here, the emphasis was on determining a desired state of the environment for 2020, and the constraints that had to be overcome so that the preferable future could be achieved.

The results of the workshop are presented in the report *State of the Environment in Southern Africa* to encourage the development of a "recipe for improvement." The chapter itself is composed of three parts: the positive and negative environmental trends; the current trend scenario; and the desired future scenario.

Source: Southern African Research and Documentation Centre et al, 1994.

**BOX 6-3**

**GLOBAL ENVIRONMENTAL OUTLOOKS**

**State of the Environment Reporting at UNEP**

The State of the Environment Reporting Unit (SOE) in the Division of Environment Information and Assessment (DEIA) of the United Nations Environment Programme (UNEP) aims to provide information for strategic environmental policy development. This is accomplished through the continuous review of the state of the global environment, analysis of linkages between the environment and human activities, identification of emerging issues and priorities for international action, and support for information capacity building at national and regional levels. Untill recently UNEP produced various state of the environment reports including a biennial statement to UNEP's Governing Council, various regional and sector assessments, and a ten-year comprehensive state of the environment report. In response to the needs of governments, emphasis will now be placed on the production of biennial more directly policy related, future-oriented assessments called *Global Environmental Outlooks*, which will culminate in ten year comprehensive SOE reports.

**Global Environmental Outlooks**

Global Environmental Outlook (GEO) reports will address sustainable development from an environmental perspective. They will focus in an anticipatory way on the processes and mechanisms underlying the relationship between environment and development. Through the active participation of a number of collaborating centres, expert working groups and a regional consultative mechanism, regional priorities and perceptions will be included together with global perspectives. The approach used will include qualitative, exploratory assessments based on expert consensus as well as quantitative evaluations where adequate data and models exist. In the longer term, it is anticipated that GEOs will emphasize quantitative approaches as experience is gained, and improved information and models are developed.

The objectives of the GEO project at international and regional levels are to:

- provide insight into the interaction between socioeconomic, environmental, and institutional factors, using new methods and tools to analyze these interactions;
- assess, through an iterative and collaborative process, progress towards sustainable development;
- identify strategic and emerging issues that require policy attention through projections, scenario development, and forecasts;
- support international policy setting and action on priority issues; and
- strengthen capacities for integrated assessments, informed decision making, and equitable participation in international negotiations.

**Progress**

The GEO project is at an early stage. Achievements include the development of a conceptual framework for integrated assessment and reporting, the establishment of a network of collaborating centres, and work on the scope, structure and content of the initial GEO. The first prototype issue of GEO will come out in early 1997 to coincide with the next UNEP Governing Council meeting and the evaluation of progress under Agenda 21. The experience will be used to complete more comprehensive GEOs in 1999 and 2002, the anniversary of UNEP's next ten-year comprehensive global assessment.

Sources: United Nations Environment Programme, 1995; Swart and Bakkes, 1994.

## 3 Quantitative Forecasting

The Dutch have the most experience of any country in the use of continuous forecasting in the context of SOER. This experience is primarily related to environmental quality issues. The basic approach is being applied through Dutch cooperation internationally and in other countries (See De Kruijf et al, 1994; Hettelingh et al, 1992; and National Institute of Public Health and Environmental Protection, 1992). At the regional level, comprehensive scenario development has been extensively applied in Latin America using land use change as a key determinant of a sustainable future. The spatial application has been primarily for the continent as a whole, or for environmental life-zones which are primarily defined by vegetation and land use (Winograd, 1995).

State of the Environment Reporting in the Netherlands

In the Netherlands since 1988, SOER has been used to raise public awareness and set the stage for environmental policy making. A series of national environmental outlooks is used as the scientific foundation for the development of national environmental policy plans. While there is close collaboration between the assessment of past and future environmental conditions and the development of environmental policy, the two dimensions are kept distinct primarily through the separation of institutional responsibility. The SOE scenarios, as defined by the government, are developed by the National Institute of Public Health and Environment (RIVM), in cooperation with other research institutes with scientific expertise in particular fields. These institutes are seen as credible and independent by all societal groups. Responsibility for translating the findings of the outlook analysis into national policy lies with government ministries such as the Ministry of Housing, Spatial Planning and the Environment in cooperation with other levels of government and sectoral interest groups.

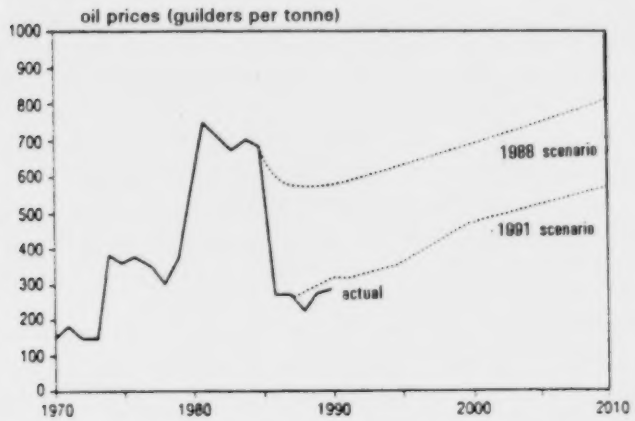
The national environmental outlooks assess the past and current state of the environment, and provide a forward-looking analysis of future environmental trends related to priority Dutch environmental issues. This is accomplished through the use of integrated and linked models to assess the impact of underlying socioeconomic pressures and existing policy on future environmental quality levels. These levels are compared to established targets commonly set through consensus on no effects levels which are used as a reference to progress towards sustainability. Thus, suggested priority areas for future policy are provided for public discussion and decision making.

Since 1989, three national environmental outlooks have been completed by RIVM (Langeweg, 1989; National Institute of Public Health and Environmental Protection, 1991 and 1994). These documents have supported the development of national environmental policy plans in 1989, 1990, and 1994 (Netherlands Ministry of Housing, Spatial Planning and the Environment, 1994). The outlook reports recognize the limitation that they only provide a momentary impression of what could happen to the state of the environment. However, this progression of continuous reporting has enabled the Dutch to improve and update their scenario analysis to take account of improved information on the state of the environment including the effects of policy implementation. It also permits the incorporation of changing circumstances related to the underlying socioeconomic pressures.

With this approach, uncertainties are accommodated as much as possible within an integrated cause-effect framework. In the 1991 Outlook, a number of changes which become evident subsequent to the initial analysis were factored into a new scenario to provide adjusted estimates for the future levels of such issues as acidification and climate

change (National Institute of Public Health and Environmental Protection, 1991). These factors included lower energy prices, higher population increases, a more open European economy, more efficient, but heavier vehicles, and increases in distance travelled (see Figure 6-1). Models are used to quantify these linkages.

**Figure 6-1**
**World Oil Prices and Dutch Forecasts**




Source: National Institute of Public Health & Environment, 1991

In the first two outlooks only one socioeconomic scenario is examined. This largely corresponds to a business as usual scenario based on medium economic development, correcting existing pollution problems, and moving towards sustainability. In the third outlook, two new scenarios are adopted in recognition that it is impossible to draw up a single most probable long-term forecast (National Institute of Public Health and Environmental Protection, 1994). The **European Renaissance Scenario** is optimistic about economic and environmental cooperation throughout Europe including the restructuring of eastern and central Europe, the social acceptance of environmental policy, and economic growth. The **Global Shift Scenario,** on the other hand, is more pessimistic over European economic cooperation, progress with environmental policy at the international level, technological development, and lower energy prices. Furthermore, additional scenario variations for energy, traffic, and climate change are developed to take account of considerable uncertainty over future fuel prices. It is believed that these two scenarios, together with the variants, provide a frame of reference within which actual economic and environmental developments will take place.

The overall goal of the Dutch government is to move to a sustainable society within one generation. The focus is on the national situation, but international and sub-national factors are taken into account. It is recognized, for example, that the application of environmental policy on a sub-national basis can be more efficient as variations in the buffering capacity of the environment can be taken into account. In the more recent outlooks the emphasis is moving progressively towards sustainability. To keep the scenarios realistic, a fine balance is recognised between the requirements of full sustainability, and the awareness and receptivity of the public. In this equation, the cost of achieving the environmental quality improvements are calculated and fed into the economic models of the Dutch government. In this way, the three outlooks gradually move from the assessment of measures which can be regarded as curative and relatively easy to achieve, to consideration of structural changes to production and consumption patterns.

Land Use Forecasting in Latin America

In Latin America, the Ecological Systems Analysis Group has completed a number of studies which forecast the state of the environment within the context of achieving sustainable development. This research has been conducted from a focus on land use (see Winograd, 1995; Gallopín et al, 1991; and Gallopín, 1990). The model adopted for the analysis is loosely based on the pressure-state-response framework. Socioeconomic pressures such as population, energy use, and agricultural development result in impacts on ecosystems. Changes can be anticipated for such factors as land use, biodiversity, forests, rangeland, freshwater, and coastal resources. Emissions and environmental quality are regarded as additional impacts. Response represents the summation of societal actions viewed against progress towards or away from sustainable development.

The main purpose of the studies is the examination of the ecological and technical feasibility of moving to sustainable development over the next 40-50 years. The amount of land and its productive capacity in relation to satisfying the population's basic needs are seen as critical information requirements. Alternative scenarios are used to forecast the results of various development options on the future state of the environment.

Vegetation life-zones are used as an environmental basis for spatial analysis. A land use change simulation model calibrated using available data for the 1980-1990 period is run for the selected scenarios for each of the life-zones. The model recognizes seven land use categories based on structural, functional, and productive characteristics (see Figure 6-2) (Gallopín and Winograd, 1990). The following land use typology is used:

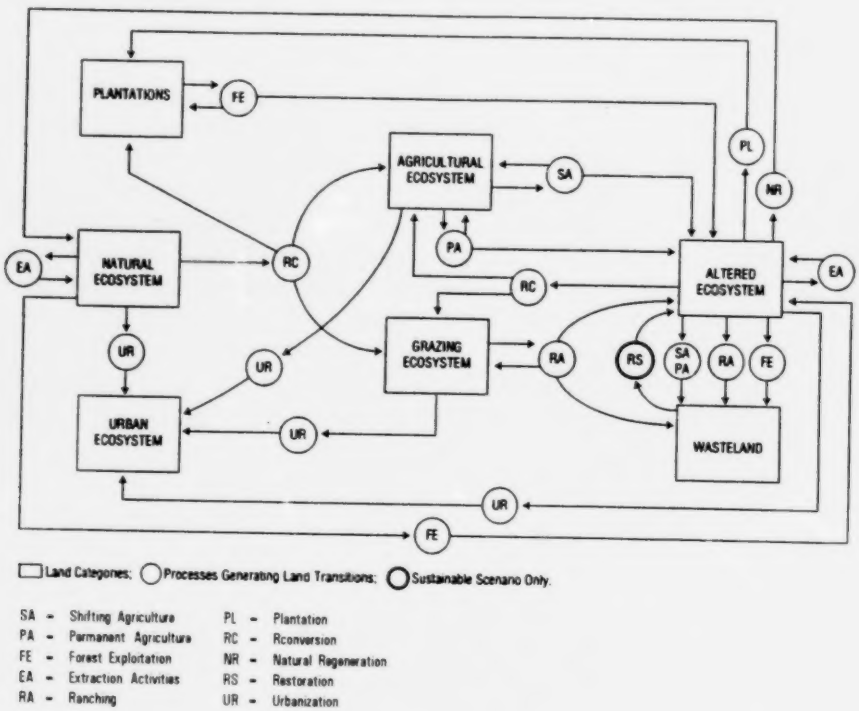
- **Natural**: virgin areas, and areas with past alteration but similar to the original ecosystem;
- **Altered:** a mosaic patchwork of land under production and land with original and secondary vegetation, and areas with slight to moderate soil erosion;
- **Agricultural:** annual, permanent, and non-traditional crop areas, including fallow;
- **Grazing:** ranching on natural or artificial pastures;
- **Plantations:** reforested areas used for forestry and watershed protection;
- **Wastelands:** unproductive lands transformed by extreme soil erosion and desertification;
- **Urban:** urbanized areas, mainly cities.

In the model, annual land use shifts are calculated by life-zone according to the intensity and nature of the pressure from human activities as defined by the scenarios. The model takes into account the current situation, the assumed rate of growth, and the availability of land. The model used calculates land area and land use change. Production is subsequently estimated from expected improvements in agricultural yields.

In the studies, two contrasting scenarios are used to illustrate future environmental consequences to the year 2030. The **Reference Scenario** recognizes the current situation and emerging trends. The pattern of development would remain essentially unchanged under market forces, with moderate economic growth after an initial period of stagnation. Current social inequities would be maintained or increase. Environmental policies would

continue to be weak, with continuing pressure on the environmental base. The alternative, the **Sustainable Scenario**, emphasizes satisfying the needs of the population through economic and social reform, the greater recognition of land capability, and the implementation of national and local environmental policies. In addition, this scenario calls for the restoration of dehabilitated areas; the integration of productive rural land use systems; and the blending of traditional and new technologies.

**Figure 6-2**
**Latin America Land Simulation Model**




Source: Gallopin & Winograd, 1990

The results from the simulated scenarios show that Latin America could evolve towards a sustainable future. Environmental conditions are outlined in terms of soil erosion, water quality and flooding, deforestation, biodiversity, and emissions. Natural resources, population levels, and technology are not limiting factors. Rather, the level of achievement of sustainable development will be determined by the policy and development paths chosen by the countries of the region.

## 4 Key Questions and Considerations

For SOER to be dynamic and comprehensive it must focus on past, current, and *future* conditions and trends in the environment. This will maximize the usefulness and relevance of the environmental reporting for awareness raising and wise decision making. In this way, SOER not only provides the basis for the assessment of existing policies and programs, but also serves as the platform for the rational development of new measures. In this task, however, it is imperative to maintain the scientific and credible nature of the prospective analysis. The objective is to tackle the scientific uncertainties in an unbiased way and distinct from policy setting processes (Maas).

Forecasting the future state of the environment can be framed by a number of key questions. The questions relate to the relationship between socioeconomic developments and environmental change; and the current and future state of the environment. The initial step is to determine the significant socioeconomic developments that impact on the functions of the environment and cause change. Subsequently, the forecasting analysis discusses the changes over time of the different components of the environment, emphasizing linkages and interactions. This would include an assessment of the future state against available reference values. The selected time frame for the diagnosis and prognosis is important. For an integrated assessment, a 10 to 20 year period is typical for determining the past and present conditions, while 25 to 40 years is a characteristic term for the forecast.

Of course, forecasts can only be based on simulated scenarios and data. Thus, the open, inclusive, and consultative approach characteristic of SOER as a whole, is especially critical for reaching consensus, credibility, and social acceptance. This is valid whether a qualitative or quantitative approach is used. The choice and scope of the scenarios need to be selected with care with all assumptions explicitly articulated. Normally, more than one scenario is needed to accommodate uncertainties and to encompass a range of future developments. The limitations of databases and models for socioeconomic and environmental analysis should be clearly recognized. Under these circumstances, continuous scenario development will facilitate improved forecasting based on the incorporation of improved knowledge, data, and models. It is recommended that this successive evolution be regarded as an integral part of the SOER production cycle.

# VII REPORTING PRODUCTS AND THEIR DISSEMINATION

## 1 Products--the Output of Reporting

The products of an SOER program represent the end results of interpreting and assessing the state of the environment. They are the essential communication link between the program and the clients, who represent the starting point for any consideration of products if SOER is to deliver demand-driven environmental information. Yet, individual SOER programs tend to struggle when it comes to specifically determining target client groups and developing products for these groups. This is exacerbated by the broad and diverse community of users interested in state of the environment information. Comolet in this context recognizes three general categories of users: decision makers and administrators; the scientific community; and the general public (Comolet, 1993). Others provide a more precise breakdown of user groups suggesting some combination of the following categories: the general public, interest groups, policy decision makers and their analysts, the education community, industry and their associations, regional and community planners, natural resource managers, the media, scientists, and consultants.

Within the overall requirement for accurate, credible, and up-to-date information, each of these groups has different needs (Australia Department of Environment, Sport and Territories, 1994). Scientists and resource managers, who already possess a wealth of detailed information for their own speciality, require data and information on subjects beyond their own field for context and for the study of relationships and interactions. The general public and community groups tend to want broader assessments of the state of the environment. They do not require detailed data, but require an overall sense of whether environmental conditions are improving or deteriorating. Decision makers in the private and public sectors need very succinct, aggregated information on the state of the environment to provide a perspective of policy and development interventions in the environment. The education community requires SOE material that enriches and assists teaching environmental studies.

Being more specific about user needs is difficult. Client groups can be extremely complex and diverse, and they are often not very specific about their information requirements, at least in the planning phases of products (United Nations Environment Programme, 1993a). Delivering relevant information to a variety of clients ranging from interested individuals to senior government officials and corporate executives represents a challenge for SOER (Environment Canada, 1992a). Nevertheless, if not enough attention is paid to user needs, products can be incorrectly targeted resulting in lack of interest, and even adverse feedback.

In SOER a balance must be struck between comprehensiveness and synopsis. Typical SOE reports have tended to be exhaustive, all-inclusive volumes usually more than 100 pages in length (See Table 7-1). If a combination of organizational frameworks is used to structure such a product it can become unwieldy and repetitive. Such products act as an excellent reference, but this can be an impediment to those with little time for in-depth review. In addition, the media of dissemination is an important consideration in delivering information to users. Traditional SOE products have tended to be printed reports, albeit often with a profusion of illustrative material (See Table 7-1). However, audio-visual and electronic products provide flexible formats that are often preferred by certain users, such as young people. An electronic format, for example, has the potential to overcome the cumbersome characteristics of large comprehensive products through rapid search capabilities.

**TABLE 7-1**

**FORMAT OF SELECTED SOE REPORTS[1]**

| Country | Number of Pages | Layout (%) | | Subject division (%) | | |
|---|---|---|---|---|---|---|
| | | Text | Tables, Figures, Graphics | State of the Environment | Socio-economic Development | Strategy for Improvement |
| Tunisia, 1994 | 125 | 70 | 30 | 20 | 10 | 70 |
| Uganda, 1994 | 238 | 50 | 50 | 25 | 25 | 50 |
| Southern Africa, 1994 | 321 | 80 | 20 | 70 | 5 | 25 |
| Western Samoa, 1993 | 76 | 60 | 40 | 68 | 24 | 8 |
| China, 1993 | 16 | 100 | 0 | 50 | 0 | 50 |
| Israel, 1994 | 255 | 95 | 5 | 10 | 5 | 85 |
| Japan, 1993 | 37 | 50 | 50 | 60 | 10 | 30 |
| Sri Lanka, 1994 | 190 | 80 | 20 | 35 | 45 | 20 |
| ESCAP, 1990 | 352 | 40 | 60 | 40 | 10 | 50 |
| Czechoslovakia, 1992 | 120 | 80 | 20 | 60 | 20 | 20 |
| Estonia, 1992 | 92 | 60 | 40 | 70 | 5 | 25 |
| Poland, 1993 | 191 | 60 | 40 | 20 | 25 | 55 |
| Ukraine, 1994 | 40 | 70 | 30 | 50 | 5 | 45 |
| Austria, 1994 | 168 | 70 | 30 | 65 | 5 | 30 |
| Finland, 1993 | 163 | 40 | 60 | 70 | 15 | 15 |
| Italy, 1993 | 490 | 60 | 40 | 45 | 35 | 20 |
| Netherlands, 1995 | 94 | 70 | 30 | 40 | 20 | 40 |
| Nordic Countries, 1993 | 211 | 40 | 60 | 90 | 0 | 10 |
| Europe, 1995 | 614 | 40 | 60 | 50 | 20 | 30 |
| Canada, 1991 | 400 | 50 | 50 | 70 | 10 | 20 |
| U.S.A. 1993 | 518 | 50 | 50 | 45 | 20 | 35 |
| Mexico, 1994 | 376 | 70 | 30 | 30 | 20 | 50 |
| OECD, 1991 | 297 | 70 | 30 | 50 | 25 | 25 |
| UNEP, 1992 | 837 | 70 | 30 | 50 | 20 | 30 |

[1] Full citations for the national and international SOE Reports listed are contained in Annex 1.

This Chapter examines the closer targeting of outputs to clients through the adoption of an integrated family of products and the use of a variety of reporting media. In addition, it discusses some of the more practical factors related to the development and dissemination of SOER products. These elements include the use of production guidelines, considerations related to cost recovery, and marketing and communication mechanisms.

## 2 Family of Products

The aim of any SOER program is to maximize the dissemination of integrated environmental information within the available budget. This has often been interpreted as the periodic publication of one document assessing environmental conditions and trends for the total country or region. However, from the viewpoint of meeting the diversity of user requirements this can only be regarded as a basic minimum. Instead, the development of an integrated family of products represents a goal that SOER programs should strive to achieve, if they are to satisfy diverse user needs.

What measures can be used to reflect as much as possible the conflicting realities of budget limitations and user needs? Moving towards a family of products does not imply that the periodic comprehensive report should be replaced. Rather, two complementary approaches are possible, both of which recognize the pivotal nature of a periodic national or regional assessment. Both approaches should be based on the development of an integrated, complementary cadre of products, rather than the ad hoc production of largely independent outputs. In addition, partnerships may well be necessary to achieve an extended range of SOER products.

In the first strategy, the comprehensive baseline assessment represents the stepping stone for summary or derived products, developed at little additional expense compared to the investment in the original product. A summary document or video could be produced for those people who require the highlights and overall conclusions of the comprehensive assessment. The use of a synthesis document can also be used to reach people with special requirements, such as ethnic or minority language groups. Or, a teacher's kit could be produced to make the results of the comprehensive assessment more useful for high school education. A derived cartoon format could be useful in getting the message across to younger children (See, for example, Government of Japan Environment Agency, 1992).

In the second strategy, specialized or interim products are issued which cover a selected aspect or component of the state of the environment. Such products could be designed to provide an assessment of trends and conditions for one particular environmental issue, ecosystem, or environmental media. They would provide more in-depth treatment of a topic than possible in the periodic comprehensive assessment. In addition, interim products can be used as prototypes to test new dimensions of reporting. If planned as an integrated package, interim products can be used as the building blocks for subsequent comprehensive assessments. Canada, for example, has used this approach to address the broad area of consumption and lifestyles in relation to the state of the environment (Environment Canada, 1993b, 1994c, and 1995). This topic will subsequently be included in its 1996 national assessment.

Other more specialized outputs can contribute to the overall family of products. These would include technical documents discussing methodological and technical developments in reporting, proceedings of consultations and workshops, and marketing material (such as a newsletter) to support product dissemination or overall program communications. The development of databases and maps represent other valuable reporting products useful for

certain users. A suggested range of generic product types is listed in Table 7-2. The appropriate range of products must be determined by individual reporting programs taking into account objectives, user needs, and budget. However, the progression of products in Table 7-2 can be used as a rough guide for deciding on the right mix taking into account user sophistication, program size, and corporate experience. Figure 7-1 provides an overall impression of the potential users for different types of products based on the level of detail of the SOE information.

In addition to greater user satisfaction, a diverse family of products has other advantages. From a practical viewpoint, interim and derived products, by providing a more stable work load, are less demanding on the staff and fiscal resources of the reporting agency. In addition, a steady stream of products maintains a continuous profile for the SOER organization compared to the periodic, isolated release of a single comprehensive assessment. A range of products will have greater appeal to potential partners, who may be interested or have the expertise to contribute to SOER. In summary, an integrated family of products provides the comprehensive coverage required of SOER, while the individual products can better serve more specific client needs.

**TABLE 7-2**

**POTENTIAL TYPES OF SOER PRODUCTS**

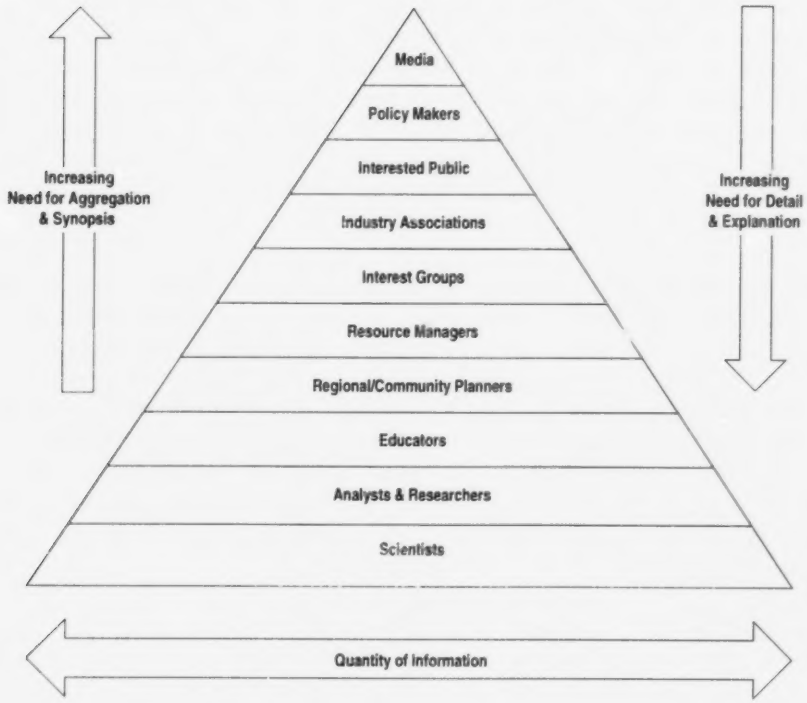
- Periodic Comprehensive Assessments
- Summary and Highlight Documents
- Statistical Compendia
- Indicator Reports or Bulletins
- Condition and Trend Maps and Atlases
- Special Regional and Topical Assessments
- Emerging Theme Reports
- Educational Material
- Promotional Brochures and Newsletters
- Technical Papers/Workshop Proceedings
- Integrated Data Sets

## 3 Product Production Guidelines

Normally, several people with differing responsibilities are involved in the production of an SOER product. In addition to writers, people with coordination, data supply, peer review, and technical responsibilities (for example, editing and map creation), are usually included in the designated team. In order to achieve consistent and high quality products efficiently,

guidelines for product preparation provide a common, unifying reference for everyone involved. Such guidelines would discuss the context of the program and specific product, define the target audience, outline the storyline and main questions to be addressed, specify the style and writing convention to be used, outline responsibilities and provide contacts, and determine the information flow and schedule.

**Figure 7-1**
**Information Requirements of Various Users**




Production guidelines have been developed as technical documents by a number of SOER programs (See, for example, Arctic Monitoring and Assessment Programme Secretariat, 1995; Economic and Social Commission for Asia and the Pacific, 1994; and Environment Canada, 1993a). Some of the more common elements of such production guidelines are described below:

- **Context**: The introductory section to the production guidelines would briefly outline the purpose, mandate, experience, and range of products of the reporting program.

- **Responsibilities:** Brief terms of reference for each group contributing to the development of the particular SOER product under development would be given. This section would stress the linkages and communication aspects among the team members.

- **Target Audience:** The targeted user group for the product should be specified, together with guidance on the appropriate level and style of writing. It is common for SOE products to be written for the non-specialist, with concepts and technical terms clearly explained.

- **Structure:** This section should outline the key themes, approaches, and messages to be covered by the product. The basic SOER questions posed in Table 1-1 of Chapter I provide guidance for the overall product structure. The approach used, including the organizational and spatial framework to be applied, could be developed from the conceptual material outlined in Chapter III. The inclusion of an annotated outline would provide the starting point for the preparation of draft sections of the product. Comments on the size of the overall product and each section would provide additional guidance to writers and other team members.

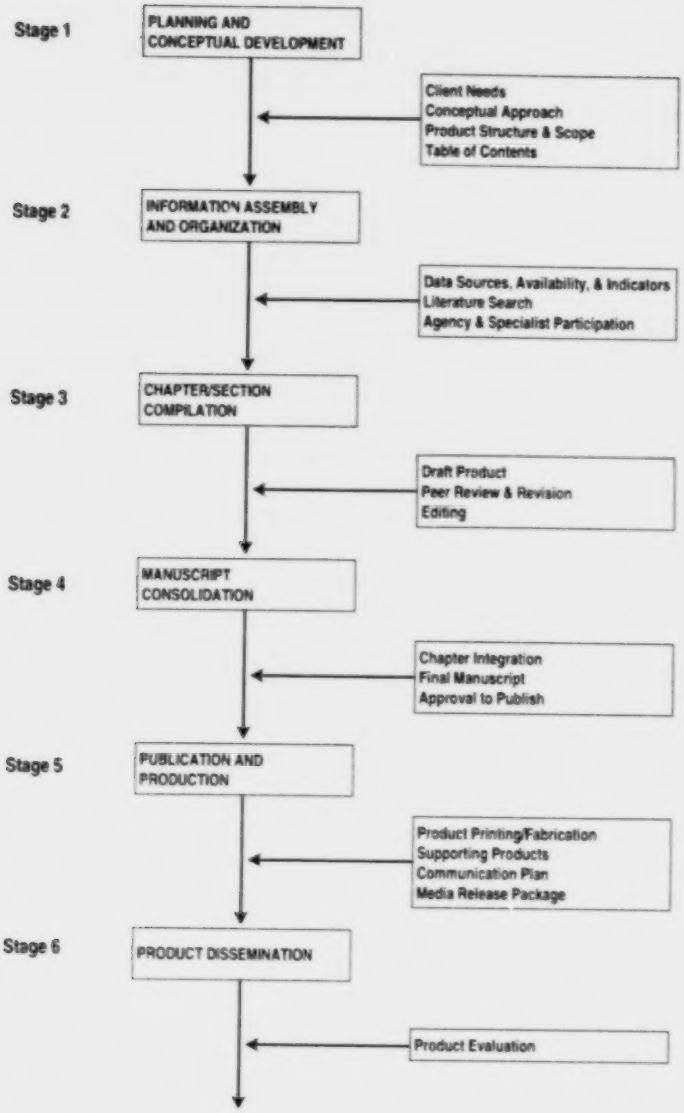
- **Contents:** The discussion on target audience and structure should be reinforced by additional reference to the product's contents. A standard SOER product will usually have a balance of text, tables, and graphics (Table 7-1). Emphasis on the use of graphics, maps and other illustrative material will help capture the user's interest. Boxes can be used to provide complementary information to the overall storyline of the main text. Comments on components of the product that are supplementary, but essential elements of a manuscript should be included. Such aspects, for example, would embrace the requirements for referencing and a glossary of acronyms and abbreviations.

- **Data Quality and Use:** The guidelines should discuss the availability, quality control standards, and use of data. Orientation to potential sources of data should be provided. Guidance on whether official, non-governmental, and traditional sources of data are acceptable; and whether writers are free to use both published and unpublished data would be useful. New data add currency and extra value, but quality control and confidentiality are important considerations. For each data set used, it may be appropriate to request writers to provide a rating of quality assurance. It may be necessary to restrict the use of new data to the SOER product only to protect the interests of the data supplier; with additional applications subject to appropriate authorization procedures.

- **Critical Flow:** The major stages, milestones, and schedule for the product can be summarized in the form of a critical path. Significant steps include a planning and conceptual stage; data and information assembly; drafting of sections or chapters; peer review and revision; total manuscript consolidation and finalization; publication and production; and dissemination and communication. The sequencing of these steps and the results attained are illustrated in Figure 7-2. Another example of these basic steps in relation to database development is shown in Figure 4-1. In complex products, consisting of many components from a number of contributors, it will be necessary to carefully consider the phasing of each component through the various production stages.

- **Style Conventions:** The guidelines should provide direction on the writing style and convention to be used in order to achieve quality and consistency. Comments on the convention for reference citation, bibliographic format, units of measure and technical terms, acronyms and abbreviations, spelling, and punctuation should be included. This should be supported by a listing of the appropriate technical references to be consulted. These aids to writers, editors, and reviewers would include the preferred writing style manual, general and subject area dictionaries, and references for geographic and organization names.

**Figure 7-2**
**SOER Product Preparation Stages**




- **Circulation and Submission of Material:** This section would supply a checklist of the preparation steps to be completed prior to the submission of draft or finalized manuscripts. In addition, the section would cover the use of copyright material, the appropriate software, and the format and identification for submitted material (hard copy, type of diskette, word processing and graphics software, etc).

- **Contacts:** A list of contacts for general and specific assistance would be helpful to all team members. Appropriate people to respond to queries concerning the SOER program and its products, assist with map generation, and advise on data supply and use could be indicated.

- **Models:** This section would provide sample manuscript sections or illustrative components (for example, bibliography format) as models for team members.

## 4 Dissemination

There are at least three basic questions related to the dissemination of SOER products. First, the product medium mix has to be determined. Second, decisions associated with cost recovery and the price of the product need to be established. And third, communication and marketing aspects should be considered to maximize the reception and impact of the new SOE information.

### Product Form

SOER products have traditionally been released as printed material in the form of reports, statistical compendia, or fact sheets. This standard release medium, exemplified by the periodic comprehensive report, will remain the standard form for many people in the future. However, information technology based on improved telecommunications and computer networks is advancing rapidly and offers new, and in some respects, more effective ways of reaching clients. Print products are expensive and time consuming to prepare and disseminate. In addition, they represent a rather static form of information that is fixed until the next update is produced.

The advantages of modern information technology for SOER are considerable (Fedra, 1994). In addition to time and cost efficiencies in the production process, electronic media facilitate continuous reporting, greater information capacity, increased currency, and increased interaction and participation by the user. New information and data can be made immediately available to users on a virtual real-time basis. The reporting output can include the underlying data sets, their quality, key assumptions, and methods of analysis for those users who require this technical information in addition to the results of the interpretation and assessment. This makes reporting more open and transparent, encouraging active participation by the user rather than the more passive reception offered by traditional print products. The user can employ these information tools to explore alternative interpretations or new issue areas. With electronic search and retrieval methods, user access and choice is dramatically increased. Even with more information, users can find what they require faster than with a report, and flexible, customized output formats more fully meet the diverse needs of different users.

SOE programs are beginning to use electronic media, such as diskettes, CD-ROMs, and networked information systems to disseminate information. For some clients, this means that new skills related to computer use must be acquired. In some cases, for example CD-ROMs, it can be argued that client access to the technology is not sufficiently developed at the present time. Nevertheless, personal computer use, improvements to telecommunications networks, and access to "information highways" are rapidly changing the way information is communicated.

The Internet, as the largest and most familiar global network of computers, offers substantial potential to communicate and exchange vast amounts of SOER information. It consists of over 0 000 networks linking some 2.2 million computers in 92 countries, and is growing at over 10% per month. Australia uses the Internet primarily as an information vehicle to keep clients up-to-date on progress with SOE reporting, with new reports and the contents of newsletters listed. Norway and Canada disseminate SOE indicator information on Internet (See Box 5-2). In addition, Canada has decided to use the Internet as the primary communications vehicle for its 199 national SOE report (See Box 7-1).

Visualization of SOER information warrants special emphasis as an effective aid to communicating main messages quickly and effectively. It can also be used to reach people who have difficulty reading. The SOE analysis of printed reports can be effectively

represented by various forms of graphics including maps and photographs. The emphasis on visualization can be taken a step further through the production of stand-alone maps or SOE atlases, taking advantage of GIS technology. Other animated visual forms, such as videos, can be used to disseminate SOER information. The European Environmental Agency has issued a video to highlight the production of its first comprehensive Pan-European SOE report, *Europe's Environment: The Dobris Assessment*. Canada has used videos to explain the conceptual underpinnings of SOER within a sustainable development context.

**BOX 7-1**

**ELECTRONIC DISSEMINATION OF SOE REPORTS**

**Background**

Major changes are being introduced in the way Canada produces and disseminates its national SOE information. These changes result from user demands for currency of information, government policy on cost recovery, and emerging communication technologies. These changes will effect the production and distribution of Canada's 199 national SOE assessment where the aim will be to recover all production costs and earn some royalties for reinvestment in the program.

The Canadian Federal Government has chosen Internet as the primary vehicle for the release of its 199 national SOE report. A complementary CD-ROM to emphasize greater access to the data and the spatial GIS aspects of the assessment will also be made available to users once the Internet version is complete. The CD-ROM will use the same information base and software as the Internet version to achieve cost and time savings. Thus, electronic dissemination is determining the design, production, and distribution of this comprehensive product, rather than the traditional printing process. Experience for this endeavour has been acquired through the dissemination of SOE indicator bulletins on Internet.

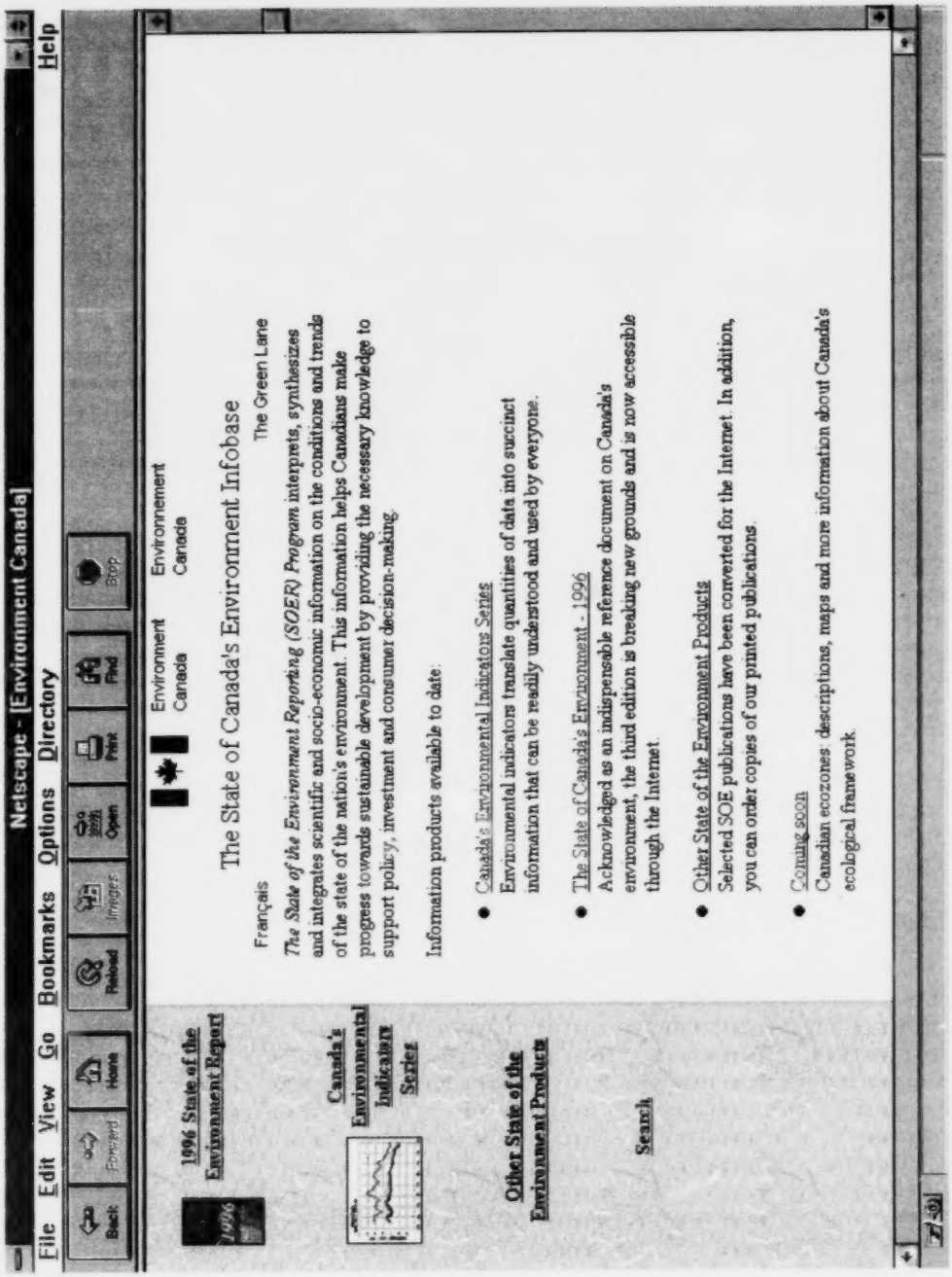
The private sector will be invited to produce a traditional bound report, and other spin-off products such as a teacher's kit, once the electronic versions have been completed. For these products, Environment Canada will maintain content approval to ensure scientific objectivity and credibility.

**The Product**

The Internet version of text, graphs, maps, and illustrations will provide greater efficiency and flexibility to both producers and users. It is estimated that production costs will be cut to 10% compared to a 750-page printed report issued in two languages. In addition, distribution and storage costs associated with traditional printed reports will be reduced. Production time from final approval of material to access by users will be reduced by 75%. It will be possible to update chapters on a continuous basis as new information becomes available. Users will gain quicker access to information and will be able to take advantage of the rapid and comprehensive search capabilities offered by the computer. To meet the requirement from many users for printed documents, a commercial on-demand printing service will provide access to chapters as they are individually finalized. This service will also allow users to customize their requests for particular sections, chapters, or the whole report.

The marketing of this national assessment will commence at least three month prior to the actual availability of report material. Chapters will be made available to users as they are produced over a period from January to June 199. Users will have free access to introductory and summary information such as key findings and the table of contents. Access to the more substantive parts of the comprehensive assessment will be on a user pay basis. A marketing survey has indicated that users are willing to pay for Internet access provided the cost is no more than for the equivalent printed material.

**BOX 7-1 (Cont.)**


Netscape - [Environment Canada]
File Edit View Go Bookmarks Options Directory Help
Back Forward Home Reload Images Open Print Find Stop
1996 State of the Environment Report
Canada's Environmental Indicators Series
Other State of the Environment Products
Search
Environment Canada
Environnement Canada
The State of Canada's Environment Infobase
Français
The Green Lane
The State of the Environment Reporting (SOER) Program interprets, synthesizes and integrates scientific and socio-economic information on the conditions and trends of the state of the nation's environment. This information helps Canadians make progress towards sustainable development by providing the necessary knowledge to support policy, investment and consumer decision-making.
Information products available to date:
Canada's Environmental Indicators Series
Environmental indicators translate quantities of data into succinct information that can be readily understood and used by everyone.
The State of Canada's Environment - 1996
Acknowledged as an indispensable reference document on Canada's environment, the third edition is breaking new grounds and is now accessible through the Internet.
Other State of the Environment Products
Selected SOE publications have been converted for the Internet. In addition, you can order copies of our printed publications.
Coming soon
Canadian ecozones: descriptions, maps and more information about Canada's ecological framework.

Source: Jean Séguin, State of the Reporting Directorate, Environment Canada. Personal communication.

## Cost Recovery

The decision concerning charges for SOER products and services is a matter for individual jurisdictions and organizations to determine. Such a decision will be influenced by the concept of public benefit and freedom of information, existing statutory requirements, existing policies and practices, an agency's operating culture, and the end use of the information (Australia New Zealand Land Information Council, 1993).

In many countries, information is increasingly perceived under a user pay philosophy as a marketable product with revenue potential to supplement limited core funds (See, for example, Chipungu and Kunda, 1994). With the reinvestment of such revenues in reporting programs, the potential to increase the scope and quality of environmental information is increased. Moving from an approach based solely on core funding to one which accommodates revenue generation for products and services represents a fundamental shift in the way reporting agencies conduct their business. The implications to mandate, client service, and line of products need to be carefully analyzed before such a move is made. Obviously, the benefits of any cost recovery strategy must outweigh the costs associated with its implementation.

Cost recovery should not be seen as restricting the public's freedom of access to environmental information. Furthermore, for information agencies, it is clear that full cost recovery is out of the question. It is generally assumed that governments have a responsibility to cover development costs related to environmental database and information formation. Thus, costs that can be recovered are usually those associated with customized production services for specific clients or client groups. In practice, therefore, a realistic cost recovery approach aims at achieving the following two objectives (Rump, 1992):

- the maintenance of efficient and effective public access to environmental information; and

- the equitable use of funds by increasing revenues where products and services are provided to individuals or specific groups.

Therefore, where environmental information is provided to the population as a whole, it is appropriate to do so without charge. This would be the case with the dissemination of SOE information through the news media or via public libraries. Similarly, it would normally be considered appropriate to disseminate sample or promotional material concerning an SOE product or program free of charge. However, most SOER products are not used by a complete cross section of the general population. Where products are individually retained, used by specific groups, or customized to meet specific needs, user fees can be justified. However, users should be consulted on prices levels and increases, especially at the initiation of a cost recovery approach.

Special considerations may be relevant in certain cases. Products aimed at the education field, for example, could be subsidized under the rationale that such use is of long-term social benefit to a country. Similarly, it would be unfair not to consider the contribution of a partner to the development of a product in any cost recovery policy (for example, the provision of data or GIS services).

## Product Communications and Marketing

The communications and marketing associated with the release of SOER information must be tailored to the particular purpose, audience, and scope associated with individual

products. A simple communications strategy consisting of, for example, a press release and marketing to agency client lists may be sufficient for interim or specialized products with a limited, well-defined user group. A more structured and integrated communications plan may be required for comprehensive national or regional assessments which serve as periodic SOE benchmarks for a wide spectrum of clients. In any event, the objective of a product communications and marketing strategy is to maximize the reach and use of the product to key audiences through the application of appropriate mechanisms (Synergistics Consulting, 1990).

The target audience for the product represents the initial focus for the determination of the communications and marketing strategy. For a general audience, the use of mass media outlets would be stressed. Special interest groups, such as non-government or professional organizations usually have their own newsletters or journals that could be selectively employed for marketing purposes. For key client groups, such as politicians, opinion leaders, or prominent decision makers, special briefings to parliamentary committees, councils, and boards may be appropriate; together with direct mailing to individual members (Campbell and Maclaren, 1995). It may be feasible to complete some audience research through a simple telephone or questionnaire survey to provide information useful for the development of the communications strategy. Such surveys could request feed-back on information needs, perceptions on previous products, suggestions for communication vehicles and distribution channels, and recommended price.

The communications strategy will obviously focus on the SOER product itself, providing an overview of the purpose and results of the assessment. The process used for the assessment may also be relevant in terms of gaining acceptance and credibility. This would be the case, for example, if outside contributions through extensive collaboration and partnerships have been employed to attain access to the best available science. In addition, it could be fitting to provide background information on the SOER program, and other available and upcoming products.

In terms of distribution channels, the basic choice rests with using internal mechanisms at the agency's or government's disposal, or using commercial publishers and media outlets. Table 7-3 illustrates the advantages and disadvantages of the several communication and marketing approaches that can be applied to SOER products. These can, of course, be used in many different combinations depending on the product in question and the local circumstances. An example of the use of a common and inexpensive vehicle, the press kit, is featured in Box 7-2.

For most products, distribution limited to direct and internal means would be adequate. This can be optimized by using several distribution outlets in addition to a main distribution centre. Such outlets could be the offices of collaborating agencies, other levels of government, or regional bureau. However, for major outputs, such as periodic comprehensive assessments and certain spin-off products, private sector involvement offers several advantages. Commercial publishers, particularly firms with co-publishing experience in science and technical products, can offer considerable design and production proficiency for an SOER program. Their distribution links to bookstores maximize the access to major products. Similarly, the use of mass media to advise of the availability of new SOE assessments considerably widens the potential market. For example, a special newspaper insert, or radio or television public service announcement would greatly broaden the marketing reach. Mass media reporting through press conferences, press releases, or interviews would further promote product dissemination.

**TABLE 7-3**

**COMMUNICATION AND MARKETING VEHICLES**

| COMMUNICATION AND DISSEMINATION VEHICLES | ADVANTAGES | DISADVANTAGES |
|---|---|---|
| Direct Marketing/Client Lists | • Targeted to known clients<br>• Low additional cost | • Ignores potential new clients |
| Selective Advertising | • Targeted to specific client groups<br>• Appropriate for products with narrow scope | • Less suitable for comprehensive, multi-dimensional products |
| Independent Endorsements | • Increases credibility and confidence in the product | |
| Press Release/Press Kits | • Focus for actual release<br>• Wide dissemination and low cost | • Passive vehicle, low involvement |
| Press Conference/Product Launch | • Focus for actual release<br>• Maximize initial exposure<br>• Opportunity to involve major contributors | • More planning and time consuming than press release |
| Public Service Advertisement | • Maximum audience reach | • Passive vehicle, low involvement |
| Newspaper Insert | • Wide audience reach | • Significant additional cost |
| Media Interviews | • Opportunity for in-depth review of the product<br>• Can involve major collaborators | • Significant preparation<br>• Time consuming |
| Special Briefings | • Targeted to major clients<br>• Opportunity for in-depth review of the product | • Time consuming |
| Government Information Centres | • Assistance for promotion and distribution | • Limited reach compared to commercial bookstore |
| Distribution Facilities of Partners | • Wider reach than internal mechanisms<br>• Increased credibility | • Key messages may get diffused |

**BOX 7-2**

**SOUTHERN AFRICAN MEDIA KIT**

**Background**

The partners responsible for the preparation of the 1994 regional State of the Environment report for Southern Africa used a extensive media kit as the vehicle to launch its dissemination. This coincided with the establishment of an Environment Resource Centre[2] in the region to promote access to environment information and expertise. The collaborative aspects associated with this initial regional assessment in Southern Africa is highlighted in Box 2-4.

**The Contents of the Media Kit**

- The Press Release Itself
- The Report's Foreword
- Report Overview
- Chapter Briefs
- The Process and Participants
- Regional/Country Stories
- A Poster
- A Report Flyer and Order Form
- A Program Brochure

**Media Kit Focus**

The press release provides the context for the total media package, announcing the availability of the report, naming the collaborating agencies, and providing a synopsis of the report's scope, structure, and approach. The release also briefly outlines the services and other products of the Environment Resource Centre. This is supported by the inclusion of a program brochure. The report overview focuses primarily on providing introductory comments on the main socioeconomic dimensions and environmental issues discussed in the report. This is expanded with half-page chapter summaries in the Chapters in Brief component of the media package.

All participants in the preparation of the report are listed to emphasise the collaborative process and the report's credibility. This listing includes members of steering and scientific advisory committees, staff, writers, reviewers, and workshop participants. A series of selected regional and country stories extracted from the report itself are included to provide local connection and interesting glimpses of the content.

Source: Southern African Research and Documentation Centre, 1994.

[2] Recently renamed the India Musokotwane Environment Resource Centre for Southern Africa.

# VIII SUMMARY AND CONCLUSIONS

In this report, all aspects of State of the Environment Reporting have been examined. The objective of the various chapters is to provide guidance to practitioners and agencies with a reporting mandate. This advice is key to the development of operational options for new or evolving reporting programs. It is supported by examples from recent national and regional reporting experience to demonstrate exemplary practises.

In building reporting capacity, organizations will face many questions and need to make judgements in establishing and operating an SOER program. Some of the more critical decisions relate to the interface between state of the environment reporting and the requirements of sustainable development policy making. Some jurisdictions will want to stress the state of the environment itself, while others will wish to emphasize socioeconomic activities and the societal actions aimed at correcting or preventing environmental problems (Canadian Council of Ministers of the Environment, 1994).

Organizations will also encounter several barriers to the implementation of a comprehensive and effective SOER program. One national survey which has general application suggests the following most common barriers:

- lack of resources devoted to SOER and conflicts with competing tasks;
- lack of organized data to facilitate integrated and comprehensive reporting;
- the demanding nature of the SOER discipline which requires a wide spectrum of subject area expertise; and
- the challenge of establishing cooperation, collaboration, and partnerships to ensure an open and inclusive process (Canadian Council of Ministers of the Environment, 1994).

This Source Book provides the guidance and information to enable organizations to choose among different approaches and levels of effort the appropriate mix for their circumstances. Such an optimum reporting program for a particular country or region will depend, for example, on the particular set of environmental issues, the experience of clients in using environmental information, and the existence of complementary reporting capacity by other groups or tiers of governments. These factors will all influence the level and scope of an individual SOER program.

Throughout the chapters a progression of reporting effort has been provided. With new staff and a new mandate, it is probably wise to start with a relatively basic program, gain experience, and then expand into more comprehensive and challenging program elements. On the question of data to support quantitative assessment, for example, the initial step would be to become knowledgeable of existing databases and data gaps through meta-database development. This could lead to the publication of a statistical data compendium. Subsequently, efforts to manage data for SOER purposes can progress to spatial integration through GIS and EIS capacity. In some cases, an early emphasis on establishing viable monitoring and survey programs where basic data is unavailable may be necessary and appropriate.

As another example, Chapter VII on SOER products discusses how a minimum program can produce a periodic national or regional assessment. As resources allow, this typical

response can be expanded to include a variety of other products including special reports, indicator bulletins, education kits, and integrated data sets. Traditionally printed products will usually be the first product medium to be used for dissemination. With experience and demand, this could advantageously be augmented with electronic and audio-visual products.

For success, the SOER program and its products must be recognized as a scientific, and integrated assessment of the condition and evolution of the state of the environment. This assessment must be acceptable and usable as a credible source of information by all potential stakeholders, including public policy makers, private sector entrepreneurs, non-government organizations, the education community, and the interested citizen (Comolet, 1993). For this role, it is important to guard against SOER becoming merely a spokespiece supporting existing government actions.

Within this context, the uses of SOER can be summarized as:

- **Public awareness**: SOER is an effective tool for informing people of the significance of the environment and natural resources in their daily lives, including focusing attention on priority environmental issues;

- **Education**: SOER provides source materials for academic and less formal environmental education for all age groups;

- **Policy development**: Within a socioeconomic setting, SOER produces the environmental condition and trend information essential for the formulation and implementation of sustainable development policy;

- **Performance assessments**: SOER provides essential information on changes in the state of the environment to facilitate public and private sector accountability of policy and development performance;

- **Scientific benchmark**: SOE products provide a baseline of integrated information against which future assessments can be compared.

In the Introduction to this report, SOER is recognized as a relatively young, and evolving discipline. In this final chapter, it is relevant to conclude with a few thoughts on current trends which will shape the scope and nature of SOER in the future.

Contemporary reporting programs are putting more emphasis on intersectoral processes, including public participation (See Table 2-3). This includes accepting wider input into the strategic development of programs and products, external contributions to the products themselves, and enhanced participation in the use of the results of SOE assessments for decision making (Campbell and Maclaren, 1995).

From a temporal perspective, there is evidence that SOER is expanding its scope from a past and present focus to encompass forecasting future states of the environment. SOER products are moving from description of issues towards the quantifiable analysis of trends and relationships. In addition, contemporary reports are changing from a segmented focus on the biophysical features of air, water, and land to grapple with environmental sustainability reporting based on a more integrated ecosystems approach. In geographic terms, environmental reporting is now completed at all levels from local to global scales; with individual products tending to include perspectives beyond the immediate product's focus. This would include, for example, national reports which analyze and interpret a

country's state of the environment within a wider regional and global setting. From an institutional perspective, credible reporting products emanate from non-government and private sector organizations, as well as government and regional agencies.

Such changes demand better and more organized data from monitoring and survey programs. In this respect, SOER programs, are moving towards the determination of appropriate indicators which succinctly capture the dynamics and complexity of the state of the environment. This is often being completed on a cooperative basis as organizations try to achieve greater compatibility and comparability within and across jurisdictions.

Many challenges remain. However, in an information age, SOER has the potential to deliver a solid foundation for rational decision making. This Source Book provides the practical set of tools to support this essential ingredient to the achievement of sustainable development.

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# ANNEX 1

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# ANNEX II

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ASEAN | Association of South East Asian Nations |
| AVHRR | Advanced Very High Resolution Radiometer |
| BOD | Biochemical Oxygen Demand |
| CD-ROM | Compact Disc-Read Only Memory |
| CEP | Communicating the Environment Programme (Southern African Development Community) |
| CFC | Chlorofluorocarbon |
| CIAT | Centro Internacional de Agricutura Tropical |
| CORINE | Coordination of Information on the Environment |
| $CO_2$ | Carbon Dioxide |
| DO | Dissolved Oxygen |
| ECLAC | Economic Commission for Latin America and the Caribbean |
| EEA | European Environmental Agency |
| EIS | Environmental Information System |
| ELMS | Environment and Land Management Sector (Southern African Development Community) |
| EMAP | Environmental Monitoring and Assessment Program (United States) |
| ENGO | Environmental Non-government Organization |
| ENRIN | Environment and Natural Resource Information Networking Programme (United Nations Environment Programme) |
| ESCAP | Economic and Social Commission for Asia and the Pacific |
| GDP | Gross Domestic Product |
| GEO | Global Environmental Outlook (United Nations Environment Programme) |
| GIS | Geographic Information System |
| GRID | Global Resource Information Database (United Nations Environment Programme) |
| IUCN | The World Conservation Union |
| N | Nitrogen |
| NACEC | North American Commission for Environmental Cooperation |
| NAFTA | North American Free Trade Agreement |

| | |
|---|---|
| NEA | National Environmental Agency (Viet Nam) |
| NGO | Non-governmental Organization |
| NOAA | National Oceanic and Atmospheric Administration (United States) |
| $NO_x$ | Nitrogen Oxides |
| OAS | Organization of American States |
| OECD | Organisation for Economic Co-operation and Development |
| P | Phosphorus |
| PC | Personal Computer |
| RIVM | Rijksinstituut voor Volksgezondheid en Milieu (National Institute of Public Health and Environment, Netherlands) |
| SACEP | South Asia Co-operative Environment Programme |
| SADC | Southern African Development Community |
| SARDC | Southern African Research and Documentation Centre |
| SCOPE | Scientific Committee on Problems of the Environment |
| SOE | State of the Environment |
| SOER | State of the Environment Reporting |
| $SO_x$ | Oxides of Sulphur |
| $SO_2$ | Sulphur Dioxide |
| SPOT | Système Probatoire d'Observation de la Terre (France) |
| SPREP | South Pacific Regional Environment Programme |
| UN | United Nations |
| UNCED | United Nations Conference on Environment and Development |
| UNDPCSD | United Nations Department for Policy Coordination and Sustainable Development |
| UNECE | United Nations Economic Commission for Europe |
| UNEP | United Nations Environment Programme |
| US | United States of America |
| WHO | World Health Organization |
| WRI | World Resources Institute |

## ABOUT THE AUTHOR

Paul C. Rump is a Canadian with extensive experience in the use of environmental information for sustainable development decision making. His experience has been gained from the local, provincial, national, and international levels. He was a member of the team that prepared the proposal for Canada's original State of the Environment Reporting program and has held various management positions in this national program. At the international level, he has contributed to various environmental information initiatives of the United Nations Environment Programme, the Organisation for Economic Co-operation and Development, and the North American Steering Committee on Environmental Information. He has also worked collaboratively with several countries, including Australia, China, the former Czechoslovakia, Mexico, the Netherlands, Russia, and the United States. Currently, he is a consultant specializing in strategic advice in the fields of environmental information, sustainable development policy development, and communications.